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Psychological and Logical[1]

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"What do these terms 'psychological' and 'logical' mean? I know what each means when it stands alone, but when they appear thus contrasted, they seem to have specialized meanings. Am I right?"

"Yes, I think you are right. As contrasted terms they were introduced, I believe, by Professor Dewey."[2]

"I know it; that's where I found them. But I wish we might talk it over. I believe it would help me at any rate."

"The clearest idea I can get is to think of the 'psychological' as the order of actual experiencing and the 'logical' as the way we arrange what we learn from the experience."

"I don't quite understand. Won't you please explain?"

"Suppose we illustrate. Take government for example. When did you first begin to learn anything about government?"

"Do you mean the very first, when I was a child?

"Yes."

"Why, I can hardly say. The earliest that I recall is when I wanted to go on a picnic with my older sister. My mother wouldn't let me and I cried. I think she punished me. At any rate I learned that there were some things I couldn't do without my mother's permission."

"Suppose we take that as a beginning, though it certaninly was not your very first. You had in this an experience of being governed and you learned something from it."

"Yes, and the next time I knew better what to expect."

"You mean that what you learned grew out of one experience and prepared for a succeeding experience along the same line?"

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1 Reprinted from March, 1922, **Journal of Educational Method.**

2 See **Child and Curriculum,** pp. 25-28; **How We Think,** pp. 61-63; **Democracy and Education,** pp. 256-261.

"Yes, that's true, though I hadn't said it to myself just that way before now."

"And is this always true, that each experience leaves some result of learning and that this resulting learning in turn prepares, in part at least, for the next experience?"

"You have in mind a succession of experiences along any one line, like government?"

"Yes, and I mean to ask whether in such a case there always is a succession of experience and result,—E^1 R^1 E^2 R^2 E^3 R^3 E^4 R^4 . . ."

"I believe you are right. If I understand you, E^1, E^2, E^3, etc. mean successive experiences of government, and R^1, R^2, R^3 refer to the successive results learned respectively from these experiences."

"Yes, and each R grows out of the E preceding and prepares you in some measure for the E succeeding."

"I am getting lost. You are going too fast for me. I see the different experiences all right. Every time Mother or Father or teacher made me do something, or set up a rule, or punished me for breaking a rule, that was an experience of government. They are the successive E's. That's clear. But what are the R's?"

"Well, let's see. By the time you began school, had you learned at home what you as a six-year-old might and might not do?"

"Yes, I was pretty well adjusted, you might say, though I would sometimes break over."

"Had you learned all this at once, as the result of just one experience?"

"No, it took a great many experiences to teach me. I remember that for quite a while I kept running away, till finally I learned that I had to have permission before I went out of the front gate."

"Did, then, your first experience of running away teach you nothing about government?

"Oh, yes. I learned that I couldn't run away without being called to account. Eventually I learned to ask permission."

"And after that another round of experiences, perhaps in connection with your brothers and sisters, taught you some-

thing about others' rights and the need to respect them."

"Yes."

"So each experience (E) does leave some deposit of learning (R), and each such R does make you look out differently—in some degree—upon the future?"

"Yes, that's clear. I see that each R not only grows out of a preceding E but also helps us face some succeeding E."

"I should like to ask here about the successive R's. Does R^3 sum up R^1 and R^2, or what?"

"Let's answer that by another illustration. Suppose a child, say three years old, is first introduced to dogs by playing with a white, playful little fellow. As he plays (E), he builds up in himself a notion (R) of what a dog is and what to expect. When his mother says that Grandmother has a dog, he expects the same kind of small white playful dog. But suppose Grandmother's dog turns out to be black, though small and playful. What will he now think when he hears that Uncle John has a dog?"

"He will think that Uncle John's dog is small and playful, but he will be in doubt as to the color."

"Does his notion (R^2) after playing with Grandmother's dog reject R^1, his former notion of dog?

"No. In part R^2 confirms R^1. He thinks even more firmly that a dog is small and playful; but in part it changes R^1. He now thinks a dog may be white or it may be black."

"And will the like process continue when he meets large dogs, yellow dogs, fierce dogs, and so on?"

"Yes, it must so continue. I see now that each succeeding R in some measure utilizes all the preceding, but it may correct their deficiencies."

"Isn't it in these different and contrasting experiences that the child comes to notice the different things about a dog?

"Yes. Suppose Fido hurts his foot and goes limping about, what effect on the boy?"

"Why, he will become more conscious of Fido's feet than before and he will also see how all four feet must work together if Fido is to run well."

"Let me say it a little more explicitly. As the child has from time to time need to think, now of foot, now of tail, now of forelegs, now of eyes, he comes to separate these out of the total notion of dog and for the purposes of thought gives them,

as it were, a kind of separate existence. This we may call differentiation of parts. Moreover, while the child is differentiating out any one part, as the foot because of the lameness, he is at the same time seeing how this part is connected with the rest: Fido needs all four feet for normal running. This we may call integration or coordination. Now I assert that differentiation and integration go hand in hand."

"Yes, that's clear. Now does not this have some effect on the successive R's?"

"To be sure. They become thus ever more complex. They have more and more recognizable parts and the parts are seen to be joined together in ever new ways."

"From what you are saying the separate parts seem to become known after the child has a notion of a dog and not before?"

"Yes."

"But is not this contrary to what we have been taught about going from the simple to the complex?"

"Do you mean that a child should build his idea of a dog as he builds a block house, one block or one element at a time?"

"Well, why not?"

"Let's try it and see how it would work. Shall we begin with the feet to build our idea of a dog. Does the child first learn the feet of the dog, and then the legs, joining the latter to the former on top? And does he then learn the body, and join this to the already waiting legs and feet? And does he next add the ideas of tail and head? Does he take each such successive step with no notion of the whole dog till he has thus built it up?"

"That's absurd! You are making fun of me."

"Not of you, but of that way of building up an idea. It is absurd, isn't it?"

"It certainly is, but now I am lost, I am afraid, entirely. How does the child build an idea?"

"Go back to the differentiation we discussed. The child saw the lame foot and so saw foot and feet more clearly than ever before. This differentiation was bringing into clearer relief what was less clearly present before."

"Yes, I see that much."

"But the notion of the dog was all the while a notion of a whole dog even from the first."

"Certainly."

"But it was not so with building the house. The first block didn't make a whole house or anything like it."

"I think I see now. The boy's first experience was of a whole dog and he got a notion of a whole dog. This notion was at first simple enough—and inadequate—but it became more and more complex and more and more adequate as more and more parts or characteristics were differentiated and integrated. However, the notion under consideration was all the time and at each time that of a whole dog."

"Exactly so."

"Well, what has all this to do with 'psychological and logical'? Have you forgotten that? What is the good of all this anyhow? What is going to come from it?"

"We do seem to have gone pretty far afield. Suppose we try to collect it all together. Imagine as regards government a very long series of experience and learning-result closely worked out, stretching from earliest babyhood up to the knowledge of the most learned scholar in the realms of thought. We may picture it in this fashion $E^1\ R^1\ E^2\ R^2\ E^3\ R^3\ \ldots\ldots\ E^{10}\ R^{10}\ E^{11}\ R^{11}\ \ldots\ldots\ E^{50}\ R^{50}\ E^{51}\ R^{51}\ \ldots\ldots\ E^n\ R^n\ E^{n+1}\ R^{n+1} \ldots\ldots$ In this the E's mean successive experiences of government and each succeeding R is the learning result that followed that experience. In every case R grows out of a preceding E and prepares, in some measure, for a succeeding E. Let's look at this series and ask some questions about it. We'll suppose we have before us the growth of the conception of government in a well taught person who comes at length to be a great authority in the subject. I ask first: Is each R made from its preceding E by conscious intent or not?

"I should say not with conscious intent. Surely as a child he didn't intend to learn. He didn't think about that. He learned, to be sure, but he didn't consciously mean to learn."

"Probably as a child he did not consciously intend his learning,—though often his parents meant he should learn,—but how about his later years?

"If he is to become a conscious student of the subject, there certainly will come a time when he intentionally studies his

experiences in order to draw from them their lessons. Even if he were not to be a scholar, he might still as a man of affairs take conscious note of what was going on so as to profit by it. So the later R's are made with more or less conscious intent."

"Can his parents or a teacher help this process?"

"Certainly. They can help the boy draw proper conclusions. I suppose in line with our previous discussions they will wish him to be purposeful in his experiences in order that he may better learn. They will also in all probability 'set the stage' or 'load the dice,' or otherwise contrive that he have fruitful experiences."

"What do you mean by fruitful experiences? Are some more fruitful than others?"

"Why certainly. In fact if parent or teacher or somebody didn't help the child, he would never catch up with what the race during untold centuries has been learning. This means, of course, wise oversight of the boy's experiences."

"Suppose the E's are the right kind, that is, purposeful on the boy's part and fruitful of result, what about the successive R's? How will they differ from each other?"

"As we have already seen, each R in turn is itself more or less of a whole, summing and supplementing and correcting the preceding. They grow continually more and more differentiated within and at the same time more and more fully coordinated. They are also, I suppose, more consciously organized—we might say more and more logical. Not only will each be more carefully drawn as a conclusion from the preceding experiences, but I think each formation of the conception will be more and more consciously made, organized on more and more rational grounds. This is what I mean by saying it would grow more and more logical."

"Let's go back a minute. How different is any E from its R?"

"If I understand you, they are different kinds of things. Any E is a bit of life itself, actual experiencing, while the R is a result in the mind, an ordering and arranging of what is learned from the experiencing. E is life, R is what is learned from life so arranged as to control better the next experience (a new E) along this line."

"Even a child profits from his experiences, then?"

"Certainly. You might say, if you wish, that each time of life has its own learning, its own arrangement of learned results, its own logic. These successive R's differ as regards organization in degree, but little if any in kind or function."

"You apply the term logical to each learning result. Do you do this deliberately?"

"Yes, I think the essence of logical arrangement is effectual organization of experience. I find this in substance—perhaps I had better say 'in germ'—in the learning of even the youngest child. The very essence of learning is for control of subsequent experience. So I am willing to say that each R from the first is for its stage logical."

"Am I to infer that by analogy you apply the term psychological similarly to each experience?"

"Yes, just as the result (R) is organized logically, so is the learning experience by its very nature arranged psychologically, that is, for learning. Perhaps the definition here lies as much in the contrast as in the terms themselves."

"I am not quite clear as to your use of the word logical. Do I correctly understand you that when the words logic and logical are used in their ordinary sense, they refer to the higher reaches of systematic organization, the kind we expect of well-disciplined minds? But when logical is used in contrasted connection with psychological, both terms vary with the development of the person: to each psychological age and experience its own logical arrangement?"

"Yes, that's the way I understand it."

"Won't you state, then, succinctly the difference between the psychological and logical order? I think I know, but I am not sure."

"The psychological order is the order of experience, of discovery, and of consequent learning. The logical order is the order of arranging for subsequent use what has already been learned.'"

"I have heard people discuss whether we should arrange a course in science, say, psychologically or logically. I think I see dimly what they mean, but I should like to see it more clearly. Can you help me?"

"I think so. Go back to our long series written down above, stretching from E^1 R^1 up to E^n R^n E^{n+1} R^{n+1}..... Let's ask, first, what is the difference between a scientist and a teacher of science,—between what a scientist and what a teacher of science should try to do? Where on this scale would the scientist as such live?"

"I suppose toward the end."

"Suppose we say he now has reached R^n and no one has gone further. Then he will try to push ahead and learn still more. He will use his R^n to map out on experiment or a series of observations (E^{n+1}) from which by careful reasoning he will hope to draw some new conclusions. If successful he will arrange his results in a form to stand criticism and present them as R^{n+1} to the world. This is what the scientist as such would do."

"Yes, I see that."

"Now by contrast suppose a teacher of science who has gone through the whole series up to and including R^n, how will he try to bring his son, say, up to R^n?"

"How old is the son and how much does he already know?"

"Why ask these questions?"

"Because he must begin where the son is."

"Do you mean that each learner is at a certain stage on this series and must begin there if he is to advance?"

"Yes, surely. How else could it be done?"

"I agree with you, but is it always so done? What about our textbooks, in physics for example?"

"What do you mean?"

"Is it not true that most textbooks take the latest results of science (R^n) and try to state them simply, then divide this material into thirty chapters and assign these in turn as lessons?"

"I hadn't thought of it that way, but I believe you are right."

"Suppose the child has reached a development indicated by R^{10}; is Chapter I (the first thirtieth of R^n) the same as R^{11}, and Chapter II the same as R^{12}, and so on?"

"Why no, that would be like building that block house, wouldn't it, a block at a time, and like getting the notion of the dog by beginning with the feet and then adding the legs?"

"I think it would be much like it. And what notion would the child have of physics after a few lessons like this? Do you

from this see the difference between the logical and psychological order?"

"I begin now to see. The logical order is taking a mental organization fit for grown-ups, chopping it into pieces, and giving it piece at a time to the child to learn. I suppose the idea is that when he gets all the separate pieces he will then have a whole. But isn't it absurd? It is in fact like building up the notion of the dog by getting first the separate notions of feet, legs, body, tail, and head, and then putting these together. I am glad you gave me that illustration."

"Isn't geometry frequently so taught?"

"Yes, always so, unless there is special preparation for the ordinary geometry book. And that's one reason why it often proves so difficult. Of course Euclid's book was for much more advanced students."

"Isn't it true that when R^n is thus cut up into pieces and assigned as so many lessons, memorizing the formulation is about all the child can do?"

"This is often so. The child's E's, then, are not real experiences, only efforts to memorize statements of the results of somebody else's experience. Under such conditions thinking, real thinking, the thinking of discovery and exploration, is pretty well prevented."

"And if the child doesn't experience, if he has no true E's, he will have no true R's, no really self-organized learning results. Am I right?"

"I think so. I see no escape from that conclusion."

"But are you not going too fast? Do you mean that the child must himself rediscover all that the race has found out? That's impossible!"

"I don't mean to leave the child without help. His process will be immensely shortened by having as a guide some one who knows the field. He is thus saved the costly blind alley wanderings. But he must himself face the essential problems if he is to organize in himself the solutions. On no other basis can he come to have an effectual grasp of the solutions as instruments of further thinking along this line. We can give him information, that bichloride of mercury is a poison. He can use this information and save himself from being poisoned; but neither chemistry nor medicine can be taught merely by

giving such information. Where knowledge and wisdom and power are sought, there must be much actual facing of difficulties. Experience in a field is necessary for anything like mastery of the field."

"I am not clear on one point. A while back we spoke of the child's having from the first a notion of a whole dog. That seemed clear then. But I fail to see the similarity between that and his work with the science. Do you mean to assert that he has from the first a notion of the whole science and that this undergoes differentiation and integration as we saw in the case of the dog?"

"Yes and no. We do not say that the notion of physics as a science was born the day the child first realized that a stone unsupported will fall, any more than we think the notion of biology was similarly born the first day he saw the dog. But any vital and natural experience has a unity that makes it a whole, whether it be of a falling stone or of a lever or of a syphon. And the child forms a notion of the experience which for him at the time is a whole, however much his more sophisticated elders may feel it as of necessity only a part of a larger whole. Later, if the child is fortunate he will have further fruitful experiences in this realm. Each such will be a whole, but oftentimes will join itself with previous experiences; and the new notion will supplement and correct the old ones. Differentiation and integration will in this manner arise, and at length what you and I call the science of physics will be born. If the boy be so inclined and is still fortunate, this likewise will undergo differentiation and integration and logical articulation with successive experiences until mayhap the existing limits of the science are reached. Throughout, if the process be normal, each experience (E) is a whole and each succesive R is for our pupil, student, and scholar at that stage likewise a whole, however partial and lopsided that particular R may later appear. But the thirtieth part of R^n is to the novice not a whole, nor is memorizing it or otherwise 'learning' it likely to be felt as a vital and whole experience of physics (though it may be felt as a real experience of bad teaching). Nor is 'learning,' in this fashion, all the chopped up parts of R^n a valid way for building in the boy the organization R^n. That can be done only by following the psychological as herein sketched."

"You are pretty hard on the logical order when used for learning. I judge you don't approve of grammar as most of us learned it."

"I certainly do not. It exactly illustrates what I mean to condemn."

"Wouldn't you on the whole mistrust definitions?"

"Yes. If I hear that a teacher requires his pupils to memorize many definitions, I have my doubts at once as to that teacher's insight."

"One further question. What does 'psychologizing subject matter' mean?"

"It refers to the work of the teacher in preparing for the learning of his pupils. In terms of our discussion it means to take a science as the scientist knows it (as R^n) and 'unscramble' it into such a series of E^1 R^1 E^2 R^2 E^3 R^3 ..... as will lead the learner from where he now is through successive experiences (E) and learnings (R) until he comes to a firm grasp of the science itself. It means to make a path of psychological order from the learner's present state up to a state where he has much experience well organized."

"One last question. You have spoken as if this applies only to science. Does it apply also to our ordinary school subjects?"

"Indeed it does. I may by elaboration say that high school science should certainly begin as general science and that be preceded by many experiences preparatory to it—not 'deferred values,' mind you, but experiences in which children live here and now. Geography should be so taught. In our best schools English grammar has already been so made over that little of the *nth* degree logical is now left. The older grammars were atrocious examples of teaching by the strict logical order. Civics is now being remade thus into citizenship. History teaching is probably scheduled for a similar transformation. Many causes are at work to make over the school subjects more and more into the psychological order. In fact our best thinkers now conceive the curriculum itself as a series of experiences in which by guided induction the child makes his own formulation. Then they are his to use."

"We have much to think over, but I believe it is worth it."

Elementary Science as a Preparation for Citizenship [1]

George W. Hunter, Knox College, Galesburg, Ill.

In the days when Roman and Grecian civilization held sway over the then uncivilized world, these nations owed their prominence to the training of their citizens. Since that day, except during the times when the light of civilization was so nearly blotted out before the days of the Renaissance, training for citizenship has only been stressed in a limited group. But today, in a democracy in a country where neither wealth nor brains nor color nor race is supposed to either delimit or limit a man from the qualifiications of citizenship, such training as will make for leadership in a democracy should be sought in all schools supported by public money.

But what, then, is citizenship? What qualities do we most admire in the citizen of today? First of all, we feel that he must be law-abiding; that he must have respect for laws binding on the greatest as well as the lowest; he should respect the rights of others; he should be able to see their point of view and at the same time understand the rights and wrongs of the men entering in competition with him; that he should have information of the sort which will be of most value in living a straight, upright and helpful life of service and that he should be able to use this information; that he should be unwilling to accept dogmatic statements on the simple "say-so" of the others and should demand as a basis a fact, which is established; that he should above all, be able to think and think straight. This last great feature is the most essential because the political life of today is swayed by unscrupulous leaders who use half-truths and *untruths* to convince unthinking and prejudiced minds. When we witness the hundreds of thousands of voters, who, because of lack of the qualifications along the lines just stated, sway our state and national politics, and when we realize that these people vote at the word of unscrupulous politicians and are moved by statements in even less scrupulous newspapers and periodicals, owned by these politicians, then we realize that our

1 Read before the General Science Section of the C. A. S. and M. T. at Soldan High School St. Louis, Nov. 26, 1921.

education for the masses is not working out for the making of thinking citizens.

But how can we evolve a training that will make for a straight thinking of the kind that will function in a democracy where votes are paid for and where numbers count? It seems to me that, primarily, respect for law can best be taught by knowledge of the law and order in nature—that order in the physical, chemical and biological world which the student of elementary science must come in contact with in a well-balanced course. It is through the laboratory work in such a course—through the project, if you will—that students come to realize the value of individual research and the need of respecting the rights of others. It is through directed information of this kind that the future citizen may get information which will counteract, to an extent, at least, the influence of untruths and half-truths which are so often published in the daily newspaper. But most of all, it is through science in the secondary school that a child may be directed into the lines of real thinking. No other one thing is so much needed at the present time as the ability to think straight. Those of us who have read Dewey's "How We Think" realize that he as a master, recognized that through the vehicle of the experiment we may teach the fundamental basis of the thought process. Someone has said that "an experiment is but a form of asking a question of nature." Nothing could be truer, and it is experimental work in the laboratory or outside of it in the form of a project through which a child of today gets his best training, that carries over into his daily life as a basis of the sylogistic form of the thought process.

It has become quite the thing for the man of today to measure himself in terms of ability or resources, both mentally and physically. The score card idea has reached down into our daily life from the business world, just as the mental test is beginning to reach into it from the university. A case in point might be the work of the Life Extention Institute. This institution, although advisedly a money-making project, has for its basis an excellent psychology, as have most successful business projects of today. The wise man is the one who sooner or later checks up on his own strong and weak points, physically. He must learn where the organism is weakest, for it is the weak link in the chain that snaps the chain. By means of such an examination as the

Life Extention Institute suggests, this chain of life may be extended simply through rightly directed knowledge of the make-up of the organism. The question then arises: should not the citizen of today be willing to put his own community to a similar test? Should we not be more willing as citizens to pay attention to the strong and weak points in our own community? For example, should we not train our children, as future members of their own community, to know something about local conditions with reference to geographical location, the amount of sunlight it gets during the year, the physical constituents of the soil; the purity and sufficiency of its water, milk and food supply, its transportation facilities, the municipal cost and distribution of such public utilities as water, gas and electricity, and the one hundred and one details of a physical, chemical and biological nature that constantly should come, but which *do not* come under the jurisdiction of the average citizen of today.

How many of us, I wonder,could score our own community with reference to the work of the health department, of its hospitals and schools, of its recreational facilities, of the cost of water, gas and electricity, as compared with neighboring sections of the country. Too many of us are entirely satisfied and some believe that because our particular town or city has certain excellent points in its favor, that no other things are needed. Is it not true that the growth of hundreds of small cities in the Middle West are today being hampered by lack of soft water or water which can be used in boilers of manufacturing plants? Frequently a surface water supply could be impounded from the surface run-off but is not, simply through the inertia of the city leaders in the public affairs. A town not far from Galesburg, Illinois, recently spent $8,000.00 on a fire engine and could not get water enough out of its mains to test the engine which had been bought! I live in a city which is mentioned by Edwin Bok as one of the three most desirable small cities in the United States in which to live. This city is well-treed, well paved and to an extent, fairly well-governed. It has perhaps a larger proportion of college graduates than most other small places, and yet it possesses an open sewer which flows through the town, reeking with odors and containing bacteria of more than several deadly diseases. The state has pointed out the danger of the open sewer and ordered its closure, but the town is satis-

fied to let the malodorous stream meander through its midst untouched. Why does this happen in such a community, you ask? Is it because it does not appeal as good business? Is it because there is no money return in it? Is it because the money expended will not show a monument to civic pride? Or is it, primarily, because the college and business men of the community have not in the past been educated to realize that public health is the biggest asset a town can have, and that it should be purchased even at a high price?

This would lead us to wonder whether our public schools have been educating in the past in preparation for every day citizenship. The citizens pay for the public schools—why should they not get some return on their investment that will be of value to them as law-abiding citizens? Therefore, why not make our science teach those things which will give the future citizen a foundation of knowledge of the sort that will make him a useful member of the community? Does our high school science of today do this? As a biologist, I am afraid that I must answer that to a great extent it does not do this. When we go into a class-room and see boys and girls counting the segments in the abdomen of a grasshopper; or observing the number of hooks and pads on the tarsus; I say with a good many other hard-headed citizens who supply money for our public educational facilities, "What practical value has this work in training for citizenship?" Or when I go into a physics class and observe the knotted brows and uneasy postures which denote disgust with mathematical calculations, I wonder just where physics is helping toward making better citizens. And even when I observe spectacular experiments in the chemical laboratory ,which fascinate and interest the citizens of tomorrow, I am prone to ask myself just where is the application in life of that citizen of tomorrow. Are we aiming along the right lines in science of today, or more properly I should say, have we been hitting the mark?

Huxley was a scientist of yesterday, yet he defined science as classified common sense. How much common sense, I wonder, is there in the work of the average science teacher which directly influences the average citizen in the average community in this country? It is not that we have not the material with which to work, for science material lies in abundance at our doors, in our homes and around about us. The child of today is

brought up in an atmosphere of practical science, and yet how many of us are explaining the problems with which he comes in contact in his daily life? There is surely as much science training in testing water for chlorides, or reading gas meters, or learning how to exterminate mosquitos, or testing grain for germination, or doing the one thousand and one practical things that the average citizen in a small or large community needs today, as there is in working out forty experiments in physics or sixty in chemistry for the College Entrance Board examination.

Biologists of today know, all too well, now that Israel Zangwell's "Melting Pot" is an impossible dream. They know, that intermarriage between races invariably drags the better stock down to the average of the lower and that race assimilation is biologically impossible. But the foreigner is here to stay and he must be educated in order that he at least will receive the point of view of a citizen in a democracy like ours. It is the place of the science teacher of today to realize that his place in the democracy is that of bringing this unassimilated material into at least as close harmony with the original stock of the nation as it is possible to do. Science, then, can lead us along practical lines to the goal which has been suggested by the recent report by the Committee on the Re-organization of Science. That goal is expressed briefly in the following well-known statement: Science instruction in the light of modern research in education may be made especially valuable in the realization of six objectives: namely, health, worthy home membership, vocation, citizenship, the worthy use of leisure, and ethical character-building. We, as teachers of introductory science, must constantly seek to treat our own work in the light of these objects—and we must furthermore be prepared to throw away such material as does not measure up in the testing as leading the child toward those objectives.

Let us now see if there is any practical way in which elementary science of today may actually do some of the things that have been suggested by this committee. A few nights ago I picked up one of the two daily Galesburg newspapers and in looking through the paper, culled thirty-one patent medicine advertisements from one paper. One of these advertisements occupied considerably more than one-eighth of the sheet and read, in part, somewhat as follows: "Biggest thing of the kind

ever seen here. Entire train-load of a certain patent medicine sold in Illinois and Missouri in only a few months' time." The advertisement goes on to say that the local demand for this medicine is remarkable, sales in Galesburg having reached the total of 5,224 bottles. One druggist makes the statement that "on one Saturday alone we sold more than seventy-two bottles and the sales are now averaging more than twenty-seven bottles a day. The class of people who are buying this are among the best in our city, people who are capable of judging impartially and who carry weight in their statements." The interesting thing about this medicine is that it contains in the neighborhood of thirty per cent alcohol. In other words, a city with two colleges and a college population of more than 1,200, containing a number of college graduates larger per capita than the average town, allows its drug stores to fill their windows with a patent medicine which is a substitute for whiskey and sell this to the intelligent (?) citizens at the cut rate of eighty-eight cents per bottle. This same advertisement had the effrontery to put in the statement by Abraham Lincoln, "You can fool some of the people some of the time, and all of the people some of the time, but you can't fool all of the people all of the time." It looks in this case as if most of the people were being fooled.

But how many older people as well as younger people are cognizant of the true working of the Pure Food and Drug Act? How many of them know that while it may prevent misrepresentation and mislabelling and while it places the names of certain poisonous drugs on the label, it is practically inoperative because of a lack of knowledge on the part of the people and because of the fact that the daily newspapers are subsidized by the patent medicine interests. How many teachers in this room, I wonder, know the entire working of the Pure Food and Drug Act with its lack of operation because of the Inter-State commerce laws. How many people know what their own state laws are in respect to the Pure Food and Drug Act. How many know whether their state provides for the safe-guarding of its citizens from adulteration and poisons? How many know that although certain poisons are by law placed on the labels of medicine, certain other poisons, even more deadly, are not required by law to be placed upon the labels? How many of us realize that a ghastly traffic in testimonials, bought with the life-blood of innocent women and sold at the rate of $5.00 a thousand by

regular vendors, is going on at the present time and that these testimonials are being scatered broadcast in the smaller newspapers over the land.

How many know of the work of the American Medical Association and its anti-patent medicine propaganda. Is your course in elementary science using this material and are you combatting these evils in an intelligent and systematic way. If so, science in your community is making that community a better and safer place in which to live. If not, then you have something yet to add to your course.

What better training for citizenship do we have than that of making future citizens willing to serve others in his community? Here is a type of work which might be done by all. A few years ago there was instituted in the high school in which I taught a service squad—a squad of boys who became interested in making sanitary conditions around the school better—a group of boys who were willing to give up part of their lunch period every day to supervising the room—a group who made public opinion in the schools so strong that the throwing of food and paper on the floor became almost unknown—a squad that later on came to supply a certain amount of self-government in the school and which definitely patrolled not only the school but the streets in the immediate neighborhood and made that part of th city cleaner and better. This group and its practical service were the direct outcome of the elementary biology course in the school. All of you know of Professor Hodge and his splendid work, first in Worcester in the clean-up campaigns in the elementary schools, later through the agency of his anti-mosquito and anti-fly campaigns in different parts of the country. All of us who have headed up such campaigns know what it means to see young people go out into a community and through their own efforts sway public opinion into cleaning up a community. This is not so difficult, for all one has to do is to start the public sentiment through some practical application of science and your community will take care of its part. As Gruenburg, so well said in a recent article in the Atlantic Monthly:

"The boy who learns to kill mosquitoes and to spare the lady-birds will probably not be the richer for it when he comes to make his will; but the community that learns to kill its mosquitoes and to spare its lady-birds will surely have an incalculable balance in its favor. The occasional individual who learns to avoid spitting is still exposed to infection from the spitting of others; the community that first eliminates spitting and pencil-licking will probably be the first to eliminate

the white-plague. If an understanding of the relations of bacteria and ventilation and diet and work to people's health will lead a generation of citizens to oppose with all their might the building of unsanitary dwellings, the operation of ill-ventilated factories, the marketing of unwholesome food and quack remedies, and the overworking of men, women and children, such an understanding is worth all its costs. No other knowledge given to all the children of a nation will do so much for the general welfare as an appreciation of the relations between man and the organic factors of his environment."

Elementary science should also teach conservation—and conservation in its widest and truest sense. We, of this country, have been given a great heritage in our rich mineral resources, our fertile lands, our great forests, in our oil and coal and water power, and yet how few children of practical farmers know the true meaning of fertility of the soil! How few of us realize that forest destruction is hurting the farmer of today as well as the lumberman of yesterday. How few of us realize that in the high price of commodities which we fight today, there harks back a cry to the carelessness and waste and extravagance of a generation who but a few years ago cut and hewed and devastated some of the natural resources from the face of our earth!

No one of us who has gone along the Illinois River can fail to realize the need of conservation of such a resource for future generations. Fish are extinct in certain parts of the river today. You say it was fish, or human lives. True, human lives are more to be conserved than fisheries, but the pollution of the Illinois River can be measurably lessened if private individuals are made to take care of factory wastes. It is not the pollution of human wastes that causes the fish extinction, but through the wastes which should be eliminated before they reach the drainage canal. All of this and more are topics which rightfully come under the jurisdiction of the live teacher of elementary science today.

Talking of conservation, how many of us are teaching in our conservation work the fact that there is a well established lobby backed by certain moneyed interests which is at the present time endeavoring to take away from the people the conservation rights which are theirs in our national parks. It is worth our while as science teachers to keep in touch with this situation. Bills were introduced last year which planned to take certain water power from the Yellowstone Park; dam Yellowstone Lake and ruin for all time some of the unique,

natural monuments in that park. This bill will undoubtedly come up again at the present session of Congress. The Executive Secretary of the National Parks Association as a watcher for ends bills in Washington, uncovered the other day a joker in a certain bill planned to establish a Roosevelt Memorial Park. This joker takes the rights of water power from the National Park Commission and puts it into the hands of a local water power commission. Our future citizen must be alert to save for his children the heritage which is ours today, and eternal vigilance is the necessary factor where politics play a part today.

Finally, the health of a community is a public obligation. Children should get, through their science work, the applications of science which lead to health and to future happiness of citizens. They should know about public money as spent in their town, how much the schools are doing for public health, how much money is spent on recreational facilities, how much of the public budget goes into the Health Department, and whether this health work is free from political restrictions and the will of the politician. Here too is the place, through the natural agency of the flowering plant, to introduce the children to the subject of sex so that real sex education may be built up in the biology course in the high school.

Let me not be misunderstood. Let us give a course in elementary science which shall have the basic principles of science. Let us not be superficial. Let us teach scientifically. Let us make our laboratory a place for experiments and for thought projects. Let us train above all, for straight thinking, but let us remember that the nation's greatest asset is the health of its citizens and that any course in elementary science should first of all interpret the environment of the pupils so that they may best prepare themselves for a life in that environment or for the bettering of that environment, if it is humanly possible; and second, that the scientist of today should act as a leader in all school projects with applications which make for human welfare and for faithful, intelligent and law-abiding citizenship.

Some Demonstration Experiments in an Agricultural Course

THOMAS P. DOOLEY, West Roxbury High School, Mass.

Experiment 1. THE DEVELOPMENT OF AN IDEAL SOIL.

Equipment: Large glass bowl, sand, yellow clay and leaf mold (or cocoanut fibre)

Sand and leaf mold are slowly added to about a cup of yellow clay, thus changing the color from yellow to black, and from a compact condition to a loose condition. Thus the development of an ideal soil.

Experiment 2. COMPOSITION OF LOAM

Equipment: Glass, loam, spoon and glass cover.

Place two spoonfuls of soil in glass. Fill with water and shake thoroughly, allow glass to stand for a few minutes. Sand sinks to the bottom of the glass, humus floats on top, and clay particles cloud water. Thus a thoroughly accurate test for composition of soils.

Experiment 3. IMPROPER SOIL PREPARATION

Equipment: Glass tube (cloth held over one end by elastic), sand and cocoanut fibre.

Place piece of cheese cloth over one end of the glass tubing (½ inch bore) fastening the same by means of an elastic band. Add about 1½ inches sand to the tube and then one inch of cocoanut fibre, then one inch of sand over the cocoanut fibre. Make compact. Place tubing in glass containing some water, giving the water a chance to rise by means of capillarity. It will be found that the water will have difficulty to rise through the cocoanut fibre.

Explanation: Soil should be thoroughly prepared for planting by breaking up all clods and fining all stubble, etc. If not, these clods and course litter will be turned over or under three or four inches, thus interfering with or stopping the rise of capillary water.

Experiment 4. FLOCULATION OF CLAY PARTICLES

Equipment: Two glass bottles, clay, spoon, quick lime and a drinking glass.

Place two spoons of clay in a drinking glass, add water and shake thoroughly. Place half in glass bottles, add two teaspoonfuls of quick lime to water in one glass bottle. Fill the bottles with water. Shake each thoroughly and allow to settle.

The clay particles in bottle to which quick lime is added, will sink rapidly and the water will be clear in a few minutes because the lime tends to draw the clay particles together, making the particles heavier, thus the sinking.

Experiment 5. VALUE OF A MULCH

Equipment: Lump sugar, powdered sugar and red ink.

Add some powdered sugar to top of a cube of lump sugar, place on top of upturned glass containing some red ink.

The red ink rises rapidly thru the lump sugar to powdered sugar apparently not being able to rise through the powdered sugar because of the looseness of particles.

Thus moisture may be conserved in soil by keeping surface cultivated.

Experiment 6. SOIL PARTICLES, AIR AND MOISTURE

Equipment: Marbles and glass.

Fill glass with marbles. Pour in water until glass is filled. Pour off water slowly, to show the effect of drainage, leaving about a ½ inch of water in glass.

Thus soil particles are represented by the marbles, soil air in spaces between marbles and film water on each marble with the water table.

Experiment 7. SOLUBILITY OF PLANT FOOD

Equipment: Sodium nitrate, sheep manure, hydrochloric acid and test tubes.

Add some sodium nitrate to test tube and sheep manure to two test tubes. Add water to sodium nitrate and one test tube of sheep manure. Note that sodium nitrate is very soluble but sheep manure is insoluble.

Add hot water plus some hydrocholric acid to other test tube

of sheep manure. Note that it slowly becomes soluble in a few hours.

Experiment 8. Testing Seed (Rag Doll)

Equipment: Cloth marked off in two inch squares (numbered) and corn seed to be tested.

Five seeds are placed in each square, cloth is carefully folded and rolled up, wet thoroughly and placed in vessel containing some water. The seeds are examined at the end of a week for results.

Experiment 9. Proving Soil Contains Air

Equipment: Glass of water, soil clods of loam and clay.

Drop clods in water, noting air bubbles rising. Which contains the most air?

Experiment 10. Testing Soil for Time to Cultivate

Equipment: Soil.

Take handful of soil, squeeze in hand, allow to drop to floor. If it holds form do not cultivate, if it crumbles, cultivate.

Make a marble of soil, roll it along table for above results.

Development of the Radio Telephone

Harold J. Power, Vice President and General Manager, American Radio and Research Corporation.

Wireless may be easily understood by comparing the ether waves by means of which radio messages are transmitted, to the water waves set up by a stone thrown in a pond of water. The stone causes waves to radiate in all directions from the source. Small chips on the water may be compared to receiving stations. When the waves strike the chips of wood they are set into vibration. Now in wireless, instead of water we have the ether which is everywhere and permeates even matrial things, such as wood, stone and brick. Instead of the stone we have the electric energy in the elevated wires of the transmitting station. The discovery of wireless was made by Hertz, who found that when a high frequency current, that is an electric current which changes its direction many hundreds

of thousands of times a second, was sent through a wire it caused a disturbance in the ether and waves were sent through space in all directions. These waves cut the wires at the receiving station and set up equally high frequency currents in the receiving antenna. Marconi was the first one to develop a practical system of wireless by finding a commercial way of setting up the ether waves and receiving the messages. The problem of receiving apparatus was to take the minute currents set up in the receiving wires and transform them into a type of energy which could be used to produce audible sounds or operate an ordinary telegraph sounder. The modern methods of receiving use telephone receivers to transform from electrical energy to sound waves. For instance, we have a wire strung up to the flag pole and attached to it are, first instruments for tuning the receiving station to the particular transmitting station we wish to detect. The high frequency energy set up in the receiving wires is changed to low frequency currents by vacuum tubes. In the circuit of the vacuum tubes is connected the telephone receivers through which the low frequency current passes and which in turn conveys the sound to the ears. In the early days of radio it was necessary for a beginner to spend some six months in building a set of equipment capable of receiving messages over a range of ten miles. Today it is possible for anyone to set up a receiving station in one evening and be hearing messages from places perhaps a hundred miles away. I shall speak more in detail of this later as it is one of the things we have been mainly interested in accomplishing. That is, to give the layman a set of equipment which requires no technical knowlege to operate satisfactorily. The day is not far off when radio will be used for connecting factories with one another and head offices with district offices. It will play an important part in politics because of the possibility of broadcasting which will enable the candidates for President to speak simultaneously to all the representative citizens all over the country assembled in various halls. Naturally such a course will considerably change our present social conditions. Of course the use as a means of communication from moving vehicles or from ships to shore will comprise a large and useful field of application.

Even now we are broadcasting messages nightly from our laboratory at Medford Hillside, Mass. Although this station

was designed to transmit a distance of only 100 miles, it is constantly heard as far south as Texas and Cuba and as far north as Prince Edward Island. We send out police reports for the Boston Police Department regarding stolen automobiles, thieves at large and escaped prisoners and lunatics. These messages are copied by the amateurs and given to their local police stations. The amateurs also act in recovering stolen property. Already two automobiles have been recovered by means of this service. One being by a Newton boy last summer and one within the last few weeks by a boy in Nashua, N. H. Besides the police reports, we play phonograph records and it is estimated that at least 30,000 stations hear this music every night. Tuesday and Thursday evenings we broadcast bedtime stories for the children. Now and then we have a publicity night when we explain the merits of our equipment. To interest the business men of our audience we broadcast reports on general business conditions once a month through the co-operation of the Alexander Hamilton Institute. We also have noted speakers, piano recitals and vocal selections. Sunday evenings sermons are broadcasted. It is interesting in this connection to note that we have received a good many letters from invalids who have been unable to attend church for a good many years. They have expressed great appreciation for this phase of our service.

I would like to say a few words about the policy of our company. When we decided to go into the business of designing and manufacturing equipment for citizen use we first made a survey of the market to see what equipment was available. Much to our surprise we found that it was impossible for a beginner to purchase a complete set of equipment at a reasonable price which would not require considerable technical knowledge to operate. We also found that the usual course was for a beginner to purchase a crude set of equipment and as soon as he learned something about radio and became interested in the work, either as a study or recreation, he had to junk his previous purchases and buy new. There was this continual process of junking and buying as he progressed in the science. We therefore decided that the best thing we could do would be to get out a simple receiving equipment which could be used by anyone without technical knowledge. Then with this unit the beginner would be able to receive messages and further-

more we decided that this unit should be one of a series so that as the beginner wished to obtain a more pretentious outfit it would not be necessary to throw away the first purchase but simply add to it. Therefore we designed what is named the Amrad Unit System. It can be compared to the sectional bookcase and consists of a series of standardized boxes 5x5x7 inches. The first unit, that is the Amrad Crystal Receiver is a complete wireless outfit in itself but limited in range of reception. It can be used to receive our broadcasting within a radius of 15 miles of Medford. If the beginner desires to go further and gets a more sensitive equipment, it is simply necessary to buy another box which operates in conjunction with the first receiver and immediately jumps the range to hundreds of miles. There are ten boxes in all and with a set of ten it is possible to receive messages from Europe. A sensitive receiver employs a vacuum tube as the detector and vacuum tubes as amplifiers of the signals. To satisfactorily operate a vacuum tube one must have some technical knowledge of its characteristics. You can readily see that if a beginner is given a set comprising three vacuum tubes and which is extremely selective in tuning, he will have untold difficulty in making the apparatus properly function. Our idea is to first give the citizen a set which does not require technical knowledge, batteries, etc. and then after his interest is aroused to let him purchase one vacuum tube and learn how to use it. In this process of learning he can fall back on his crystal detector if he has difficulty and so is always able to get some messages. After he has learned to use one vacuum tube it is quite easy to add other tubes and become expert in operating. It is not only a source of education for the boy or young man but a splendid recreation for the busy business man. To be able to sit down and hear various messages coming through the air one is able to forget all about his business problems of the day. For a boy, it is a remarkable thing because it teaches him how to think. Even a college education does nothing more than to teach the young man how to think logically. If he is to make any success in the world, he must be able to think logically. A boy using a radio set begins to wonder how it works and then he goes to the local library, joins a radio club and digs in to find out how it does work. This teaches him to think and

early in life he is getting the benefit of the greatest of a college education. Of course it is true that education alone does not make a man successful. In fact probably it is more important for a man to have judgment and judgment cannot be developed by study. Its development comes mainly from experience but here again a radio set for a boy throws him into contact with older men; he learns something of parlimentary practice at his club meetings; he perhaps gets actual experience in being an organizer and leader. Radio is truly a tremendous force and of much importance to everyone. Of course it will never displace the regular line telephone because each has its own distinctive field. Probably in the future radio will be used for long distance communication, such for instance as spanning the Atlantic. The day is not far off when it will be possible for you to pick up your telephone and call up someone in England. The jump being made by radio.

Our Corporation realizes the important future of radio telephony and we are doing our share in the development of the art. At the present time telephone transmitters are complicated and what is worse, are very costly to operate. Before radio transmitters are used commercially their cost of operation must be materially reduced. We have been working on this problem for several years and have now developed the basis of a commercially possible telephone. The vaccum tube is the heart of the whole thing. Present types of tubes have filaments which burn out after a comparatively short operation. Especially is this so regarding transmitting tubes. The average transmitting tube as built today has a life of perhaps 500 hours. Our laboratories have been working on a new type of vacuum tube which would not have the disadvantage of the present type. We now have a tube which has no filament to burn out and therefore has a long life. It is also capable of handling high power and so I am not dreaming when I say that the day of long distance commercial radio telephoning is not far off.

A Burroughs-Day Project[1]

NATURE STUDY CLASS, UNDER THE DIRECTION OF MISS GERTRUDE B. GOLDSMITH, STATE NORMAL SCHOOL, SALEM, MASSACHUSETTS

John Burroughs died only last April and since then we have seen many articles about him in the magazines. We read some of these and became more interested in him than we were when he was living. When school opened this fall the name of "Burroughs" was fresh in our minds. It was thus quite natural for us to choose this eminent naturalist for study as a class project.

Friends of Burroughs have planned a lasting memorial in his honor and what better memorial could there be than the places where he spent his life and where his body now lies? The Memorial Association is soliciting funds for this very purpose. It was suggested that we might help in this. After several weeks of preparation, we presented a Burroughs program to the school and after the program was given an appeal was made for contributions and a very substantial sum was collected.

The advantages received by the school as a whole by this program was expressed by pupils who said they gained from it more respect, more appreciation, more instruction, more information and more love for Burroughs as a man.

In addition to the four papers which follow, we gave a number of readings from Burroughs' works.

John Burroughs

John Burroughs, the man whom we have learned to love and revere, was born in Roxbury, New York, on the western borders of the Catskill Mountains in 1837. He remained here about twenty-six years of his young life, working on his father's farm. It was here among beautiful surroundings, that he learned, first hand, the secrets of nature and he never departed wholly from this simple life. Not long before he died, in revisiting this vicinity he lifted his eyes to the Catskill sunrise and said, "How much these dear old hills mean to me! When in my playful youth little did I think as I went along this roadway to school every morning that some day I should fall back upon these scenes for thought, love, and inspiration."

1 This article was prepared in November 1921, but because of lack of space its publication has been delayed.

His first school was called "Old Jug," and it seems that his interest in nature began to grow much keener while he was here. In early spring he would get his slate clean first among his fellow students and start off to hunt the frogs and muskrats.

* * *

At seventeen he taught school for ten dollars a month. He still worked on the farm while doing so. He earned enough money to attend a school later on. In his second term of teaching he began to write a great deal. He first copied Johnson's style. His schooling ended at Cooperstown Seminary and all the rest of his education came from his own endeavor. At this school he stood first in composition work. In poetry his taste was for Pope and Young, in composition, Addison and Lamb.

* * *

Some of the first money he earned was spent to buy a book entitled "Letter Writing" from which he modelled many of his letters to his sweetheart, "Mary."

The first time Johnny realized anything about death was when he was quite young. The housemaid came in with a pailfull of chips on which there lay a bright red bird. When the child spied the bright bird with coal black wings he jumped up and ran eagerly to view the bird. He soon learned he was lifeless. Tears filled his eyes, love and sympathy were born together in his heart. Curiosity came also, and from this time on he took a great interest in birds. This naturally lead him to be interested in hunting. He hardly ever killed a bird. One spring afternoon a vast flock of pigeons began to pour down in the beech woods on the hill by the roadside and then began to join the great number in the woods. John seized his old musket, ran out into the road, crept up behind the wall, till only the width of the road separated him from the swarm of fluttering pigeons. He pointed his gun at them and then sat spell bound. The sound of their wings and voices filled his ears. He cannot explain why he did not shoot them, but, all he knew was that when he came back to his senses they had gone.

* * *

Burroughs held responsible business and government positions. He travelled abroad and read much. Life in the city restrained him; he longed for the freedom of his youth and so we find him ere long back in the country engaged in fruit-farming.

He really longed to get back among the hills of his nativity on the return of summer. He always visited them until his health failed. It was more at this time of life that Mr. Burroughs wrote his essays, when he was able to withdraw from the worldly world and rest and work at ease.

One paragraph from Burrough's writings: "Life has been to me simply an opportunity to learn and enjoy, and through my books to share my enjoyment with others. I have acquiesced in things as they are and have got all the satisfaction out of them I could."

W. Lenore.

John Burroughs And His Friends

John Burroughs, our famous naturalist, was truly a man to be envied. He was a man of wonderful character and a great lover of the beautiful in nature. Surely such a man as he, must have been endowed with friends. John Burroughs certainly did have a great many friends both among mankind and also among the birds and the flowers. We have all heard that old expression "A man is known by the company he keeps." If we did not have any of Burroughs' words, which of course we all know portray the true Burroughs, I believe that we would be able to judge very well as to what kind of a man he was just from learning whom some of his intimate friends were. We find that most of his friends were great men, great not only by name, but of genuine characters. Among these were Theodore Roosevelt, John Muir, Thomas Edison, Henry Ford, Harvey S. Firestone and Walt Whitman.

Mr. Muir was one of Burroughs' best friends although the former was a great wandered and Burroughs was a home-lover. John Muir was greatly interested in trees and had an extreme knowledge of the phyeognomy and botany of many of the countries of the globe including South America and Africa. On their trip to the Pacific coast and the Hawaiian Islands, John Muir took Burroughs through the Petrified Forests of Arizona and in and around the Grand Canon of Colorado. Making

their camp near by the Canon, they would take day tramps in the Mojave Desert. On their way to the coast they also stopped and visited Yosemite Park and saw its wonders.

The contrast between the two nature students is very striking. John Muir talked because he couldn't help it, and his talks were good literature, he wrote only because he had to. John Burroughs wrote because he couldn't help it, and talked only when he couldn't get out of it. One writer has called John Muir, John of the Mountains, and John Burroughs, John of the Birds.

Many camping trips were made by Burroughs with Thomas Edison, Henry Ford and Harvey Firestone. Once in starting out, they camped for the night in the orchard of Woodchuck Lodge, John Burroughs' country home. Their electric lamps which Edison always carried on their trips lighted up the night and made a beautiful scene in the old orchard. Their last auto camping party together was the best outfitted of all. They had two big cars, two Fords, and two trucks One morning some one asked Edison if he would have some prunes. His quick response was "No. I was once a telegraph operator and lived in a boarding house." On this trip Edison was a first rate vagabond. He went with his hair ruffled and unbrushed clothes. He delighted the party with funny stories and witty remarks. John Burroughs had known since the time of his boyhood the biting taste of Jack-in-the-pulpit, but did not know until Edison told him that this effect on the tongue was mechanically due to tiny needles.

John Burroughs was a very great friend of Walt Whitman. For more than thirty years Burroughs kept in close association with the poet and these years he counted among the most pleasant in his life. Although many excellent critics are harsh on Whitman's poetry Burroughs appreciated and enjoyed it immensely. These two men met and cultivated each others friendship in Washington. They were frequent companions until Whitman moved to Camden in 1873. Their frieidship was of the beautiful and sacred kind and was kept up when they were apart by the exchange of visits to each other. Peculiar mountain wilderness around Slabsides induced Burroughs to name the woods about his home Whitman Land. Burroughs was so inspired by his early contact with Whitman that

his first book was "Notes on Walt Whitman, as Poet and Person." A little later he renewed his study of the poet in the last essay in "Birds and Poets." The title of this essay is "The Flight of the Eagle" and is one of Burrough's best papers. Still later he wrote his final word on Whitman in his volume "Whitman—a Study." This last volume is a complete interpretation of the poet. The poems of the man are given full treatment, and is perhaps the best defence of Whitman in print.

Another of John Burroughs friends and perhaps the most sincere was the great expounder of the "strenuous life" Theodore Roosevelt. Roosevelt often wrote letters of appreciation to Burroughs concerning his books and while the former was Civil Service Commissioner he accepted an invitation to visit Slabsides.

The really intimate friendship between the two men began in 1903. In April of that year Mr. Roosevelt asked his friend to visit Yellowstone Park with him. Many delightful and laugh provoking incidents came out of this trip. "When they entered Yellowstone Park a fine saddle horse was waiting for the President but an ambulance drawn by mules for John Burroughs. Somewhat chagrined at being met by such a vehicle, he, nevertheless, stepped inside as though accustomed to ambulances. With an escort of officers the President set gaily off with the ambulance following. And it immediately followed at such a pace swaying from side to side, that John Burroughs, grasping the seat with both hands, said to himself: 'This is a wild west send-off in dead earnest.' Faster and wilder grew the ride and looking out he saw that the cavalcade ahead had turned out for him. On they tore for a mile until they reached Fort Yellowstone. There he learned that the mules had been running away and the driver's only course had been to guide them until the hill at that point should make them pause."

During the trip Roosevelt gave to his companion that affectionate name of "Oom John" which he ever afterwards called him. Mr. Burroughs, with true respect yet with that close feeling of intimacy that we call friendship, called Roosevelt in return "His Transparency." After their return home many a letter found its way to the White House from "Oom John," and "His Transparency," though burdened with the cares of

the nation, often found time to address a letter to Slabsides. The last outing that our two friends enjoyed together was a brief visit to Pine Knot, a secluded spot in Virginia where they went to rest and "name birds without a gun."

From the printed page we feel the inspiration of the friendship of these two great souls. It is too much and too great for us to condense into so many words. We can only try to pay our tribute to Mr. Burroughs. But, even now, that fitting tribute of Roosevelt's to Mr. Burroughs—"It is a good thing for our people that you have lived, and surely no man can wish to have more said of him"—remains with us.

Catherine E. Goodhue.

Appreciation of John Burroughs by His Contemporaries

We all know that John Burroughs was greatly appreciated by his contemporaries. Some of his contemporaries, Dallas Lore Sharpe, Henry Van Dyke, the best known to us, are most fervent in their praise of him. In his book called "The Face of the Fields" Dallas Lore Sharpe gives a splendid interpretation of our great naturalist. He says:—"During the fifty years of his writing for the Atlantic Monthly, his eye for the truth of nature grew clearer, and the vigor of his youth increased into the maturity of strength.

"The eleven nature books are the most important of John Burroughs' works. In them he interprets for the world the love, truth, and charm of nature's ways as they cross with man's. His pages are open surfaces to catch the sensitive impressions of nature.

"In all his writings Burroughs shows a depth of character born of his close contact with nature. His religious essays show reverence and honest thinking, absolute and joyous faith; his poems, simple and exquisite feeling. He was an optimist by temperament. By vocation he was a writer, by avocation a vine-dresser."

John Burroughs is also compared as a writer to other literary men who take their material from nature. Mr. Sharpe calls him a real nature writer, who shapes not the universe to suit himself, but himself for the universe.

"The writings of Burroughs are free from self. They show the real writer and essayist, with a love for books only second

to a love for nature, the watcher in the woods, tiller of the soil, reader, critic, thinker, poet, interpreter of the out-of-doors."

Dallas Lore Sharpe ends his appreciation with this statement. "All of his books have a quiet fragrance, a sweetness of feeling, sincerity, simplicity, balance and finish. They turn a little of the universe into literature, translating a portion of the earth into human language."

"The making of America and of genuine Americanism has been done out of doors. The true spirit of America has found its strength and impulse and poise in direct contact with nature." Thus begins Henry Van Dyke, an ardent admirer and contemporary of John Burroughs. He goes on to say, "John Burroughs is one of the men who have done most to make this clear in American literature. The best part of his life was spent out of doors. The recording of this gives his books their wonderful charm and value. No spring comes and no fall passes but that you'll find in John Burroughs something to interpret it and make it more beautiful in your eyes.

"I put him in this respect with Gilbert White whose 'Natural History of Selbourne' has been a lasting joy to nature lovers in England. I put him higher. He was no better observer, but a better interpreter. He was an explorer in the sense that he discovered new meanings and values in natural work lying close around us. He saw the illuminating in the commonplace the easily accessible.

"His books 'Winter Sunshine,' 'Birds and Poets,' 'Locusts and Wild Honey,' and 'Riverby,' are among the few out-of-door books that stand the test of reading in camp. In them there is a feeling of nature's reality in touch with human sentiment. His spirit outlives the trees, birds, and flowers that he wrote about."

Henry Van Dyke was a close friend of John Burroughs. He says, "There is something about the companionship of John Burroughs that was singularly attractive and satisfying. He had the eyes and ears of an acute observer, but he didn't boast of it. He had a philosophic mind, he didn't wrap himself in the philosopher's mantle of obscurity or deal in dark sayings. He reaped the harvests of solitude but doesn't pose as a solitary. He liked most people, and loved many.

"His style has no crust on it. It is easy, clear, without

apparent effort, sparkling, and flows smoothly. His long life was serene, and its main issue, the communion of man with nature was successful. He helped others to understand this bond. The best way to know him was to read his books out-of-doors."

Louis A. Fuertes, a noted authority and writer on birds writes the following appreciation of John Burroughs. He states, "John Burroughs never deserted the close contacts with the earth for the comforts of the study. He called himself a farmer. He maintained an active participation in all work of his gardens and vineyards. He was not adapted to a city life. He was a contemplator, requiring quiet, peace of mind and body, leisure to observe, and close contact with the earth. The noise and clamor of the city disturbed him greatly. He made of each bird and flower a personal friend. He wrote of birds, flowers, and creatures seen daily around his house or cabin."

Another person for whom John Burroughs had a great deal of esteem, and who returned it was Theodore Roosevelt. Mr. Roosevelt was a man of similar type and nature. The two were close companions, and went on many expeditions together. Mr. Roosevelt however was a moer vivacious type than Mr. Burroughs.

The Nature Study Review published in its May-September issue, an editorial which gives us some idea of the appreciation of John Burroughs in the circle of naturalists. The article calls him the great interpreter of the teeming life of our woods and fields. It says his life was well rounded and well finished. He lived happily doing the work he loved. He was keen in interest and young in spirit. In giving the lesson of Burroughs' life the magazine quotes his own words.

"In every man's life we may read some lesson. What may be read in mine? If I myself see correctly, it is this: that one may have a happy and not altogether useless life on cheap and easy terms:—that the essential things are always near at hand; that one's own door opens upon the wealth of heaven and earth; and that all things are ready to serve and cheer one. Life is a struggle, but not a warfare, it is a day's labor, but labor on God's earth, under the sun and stars, with other laborers, where we may think and sing and rejoice as we work."

M. L. Kelley.

The Burroughs-Long Controversy in Regard to Nature Writing

"It is the demand for an article that leads to its counterfeit," wrote John Burroughs in an article on "Real and Sham Natural History" in 1903, "otherwise the counterfeit would stand a poor show. The growing demand for nature works has called forth a very large crop of these, good, bad and indifferent." Some are valuable contributions to our natural history literature, but others are written merely for the pecuniary benefit involved.

Among the worst books, were those of Thompson Seton and William Long. One of the latter's, "Wild Animals I Have Known," has been cleverly alluded to by Burroughs as "Wild Animals I *Alone* Have Known." Seton says, "Natural History has lost much because the treatment of it is so common." Therefore he endeavors to make it specific and individual. He has in one story, "a fox jump on the back of a sheep and ride several yards," he expects his readers to believe it, for he says his works are absolute observations.

There were two schools of nature writing, very antagonistic to each other—one, the new American made, sentimental school to which Seton, Long and Roberts belonged,—the other, the school of scientific nature study of which Burroughs, Muir, Thoreau and Maeterlinck were writers, this the tried and not found wanting school of nature works.

The newer school, having to do with the sentimentality of nature was fast becoming prominent, when Roosevelt was President and took his stand against the so called "Nature Fakirs," in 1907. He said, of Long's works—"It is an absurd description, not of what he has seen, but of a confused memory of what he has seen or read." They were the creators of the yellow literature of the woods. The true heart of nature had never been revealed to them, because they had not correctly observed her ways; and so knowing not the ways of nature, wrote of its impossibilities. Roosevelt upheld Burroughs in his scientific school, as a man who loved nature for its own sake and wrote his essays and poems in order that other people, less fortunate than he, might enjoy and know nature thru the course of his works.

Those to whom Long and his followers appealed brought up

many arguments to defend themselves. In Kipling's "Jungle Book" Stories, the powers of man are sometimes attributed to beasts and so they do many incredible things, but as Burroughs said,—"In Kiplings,—no one can be deceived, the stories there are distinctly humorous fiction; no one would go to Kiplings' "Jungle Book," as an authority on any works of nature. His purpose is not to enlighten, but to merely give pleasure. In Long's works, fact and fiction are constantly being confused. He invents rather than observe, and so doing he perverts natural history.

Interpretation is a favorite word with some of our recent nature writers. The ways and doings of our wild creatures are exaggerated and misread under the plea of interpretation. What is the nature writer's idea of interpretation? Does he mean,—"What is the exact truth about it? or, What does this scene suggest to you? The first meaning,—the search for the exact truth is the scientific interpretation, the second is really no interpretation of nature at all, but an interpretation of the writer himself.

In one of Long's books, he writes of a bear pawing at a tree as a would-be rival. Here his interpretation may be challenged, but he says, "There is no good literature without imagination. Men see thru their temperaments, he is telling the truth, if he tells what he sees as he sees it.

To this Burroughs replied, "Mr. Long may find in the croaking of the frogs a key to the rule of the universe if he can and be entirely within his rights. All that I demand of him is that he be sound upon his frogs. I will not even accept a toad. When he says frog it must be a frog." Let the facts set his imagination on fire, but first let him see to it that it is a fact.

Maeterlinck and Thoreau were scientifically accurate in their facts, and their works are surely of great literary value.

In another story Long is telling about a woodcock who broke his leg. Seeing some clay near by he conceived the idea of making a cast for his broken limb. Hopping to the clay he dipped in the broken leg, thoroughly saturated it with clay, and then stood upon one leg waiting for the cast to dry." It makes a delightful fairy tale, which would be perfectly good, if he claimed it to be no more than that, but he says it is the truth!!

It has been said in defense of Long, that Burrouhgs studied nature from his own small farm, while Long obtained his seemingly incredible facts from observation of animals in different parts of the country. To this Burroughs replied, very well,—"Your natural history of the East should avail you in the West," and he refers to Emerson—"there is no country where a dog is not a dog or where a hare is ferocious and a wolf lamblike."

Some people have made the assertion that Long has written for children, and Burroughs for adults. This is untruthful and unwise. Because Long's books are not to be relied upon as nature truths, it is not good judgment to place such in the hands of children. They should not learn things which they will later have to unlearn. "There is no more reason," said Roosevelt, "why children should be taught a false natural history than why they should be taught a false physical geography." We had better choose for the child an authority on nature truths, they will enjoy Burroughs, for he had a way in writing that one could not help liking. He presents facts in a way to touch the emotions and produce in some degree the enjoyment of the living reality.

Mr. Long and his followers, may and perhaps always will have their readers, but let us not accept his works as true enough to be put in hands of the children to read.

The truth in Nature writing as the truth in other things should always be considered. What good is a thing of great literary value in artistic phraseology, if the heart or the core of it is not true. Only he who is ignorant of the deepest truths of nature assumes that the imagination of mere man can add anything in the line of attractiveness, to the facts in nature, which are but the visible expression of the imagination of the Creator.

Lydia Wade, Florence Johnson, Anna Gorman.

The John Burroughs Memorial

We have honored such men as Lincoln, Washington, Jefferson, Grant, Roosevelt, Hawthorne, Whittier, Irving, Longfellow, MacDowell and others of our great patriots writers and artists. Why wouldn't it be a worthy as well as

a most delightful thing to pay some respects to our great naturalist, John Burroughs?

I am sure there is no one here who has not heard of John Burroughs. I am equally certain that there is no one who has not read and enjoyed something written by him. It is due to the fact that we wish to honor Mr. Burroughs that an Association has been formed to undertake the memorial to him: The association has on its board of directors such people as Mrs. Henry Ford, Mrs. Thomas Edison, Mr. Kermit Roosevelt and others.

It is the purpose of the John Burroughs Memorial Association to purchase and maintain as a permanent memorial the properties on which he spent so many of his 84 years.

These include four distinct locations: "Riverby" at West Park on the Hudson N. Y., which consists of a six room stone dwelling built by the author himself, in which are dated many of his books, and the "Chestnut Bark Study" in which many of the books were written, and which contains the writer's working library. A barn, a garage, and six acres of land are also included in Riverby.

Second is "Slabsides" located one and one half miles from Riverby, in the wooded hills back of the Hudson—the world famous retreat of the poet naturalist, furnished and equipped as he was wont to use it. The massive stone chimney of this cabin was built by his own hands.

Then there is "Woodchuck Lodge" in Roxbury in the Catskills N. Y., a farmhouse on the east end of the Burroughs Homestead farm which Mr. Burroughs restored and in which he spent the summers of his later life. Also the "Hay-Barn" which he used as a study and where he wrote "A Barndoor Outlook;" "A Haybarn Idyl;" and many other essays incorporated in "Under the Apple Trees;" in "Field and Study," and other later books.

Last of all "Memorial Field" in which is "The Rock" where he played as a boy and in whose shadow his body rests.

It is estimated that to acquire and restore these properties so intimately associated with John Burroughs a fund of at least $40,000 is necessary.

It is to you, the people who know John Burroughs, who read his works, and who admire and respect him that the association appeals to help them. They feel as we do that it is a privilege to be a contributor to this fund. I am sure that all of us would like to feel that we helped to honor our poet naturalist by aiding the memorial association.

Mabel Lowry.

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Cooperative Work in the Organization of Local Material for General Science Instruction: Water Supply Systems. (*Continued*)

The Water Supply System of Cleveland, Ohio.

EARL R. GLENN, The Lincoln School of Teachers College, Columbia University, New York.
ANNA LOWREY, Berkeley, California.
BESSEY K. GISH, East Technical High School, Cleveland, Ohio.
GRACE MUSCH, West High School, Muskogee, Oklahoma.
EDNA E. MARLEY, Philadelphia High School for Girls.

OUTLINE:

I. Introduction.
II. Part I. The Oakland, California, Water Supply System.
III. Part II. The Water Supply System of Cleveland, Ohio.
IV. Part III. The Water Supply System of Muskogee, Oklahoma.
V. Part IV. The Philadelphia Water Supply System.
VI. Part V. The New York Water Supply System.

Part II. The Water Supply System of Cleveland, Ohio.

A PRELIMINARY OUTLINE FOR CLASS WORK

1. The problem of an adequate supply of water.
   a. Sources of drinking water.
   b. Common impurities in drinking water.
   c. Dangerous impurities.
   d. Sources of impurities in the water used in Cleveland.

2. The history of the water supply system.
   a. Early methods.
   b. First water works.
   c. The first tunnel.
   d. Reservoirs.
   e. The nine-foot tunnel on the east side.
   f. Extension of the west side tunnel.

3. Important features of the present system.
   a. Pumping stations.
   b. Filtration plant.
   c. Method of distribution.

d. Territory supplied.
e. Total cost and cost per capita.
f. Water rates.
g. Proposed extensions.

4. How impure water is purified.
   a. General methods.
      1—In systems under municipal control.
      2—In the home.
   b. Methods used in Cleveland.
      1—Filtration.
      2—Chlorination.

5. Relation of water supply to health.
   a. Location of the cribs.
   b. The typhoid death rate.
   c. Epidemics.
   d. Faucet filters.
   e. Influence of lake currents and storms.
   f. Bathing beaches.
   g. Sewage disposal.
      1—Past methods.
      2—Recent improvements.

6. Excursion to the filtration plant.

An Outline to be Placed in the Hands of Each Pupil.

   a. Source of Water.
      1—What is the source of Cleveland's water supply?
      2—Who controls the water supply system?
      3—How many intakes are there? Where located?
      4—How is the water protected from contamination from sewage?
      5—When is the danger of contamination greatest?
      6—What precautions are taken against danger at any time?
      7—Give the sources of pollution of lake water in the vicinity of Cleveland.
   b. Methods of Transferring Water.
      8—How is water distributed through the city?
      9—How many pumping stations are there and where located?

10—Does the Cleveland system have any reservoirs, or stand-pipes?

11—Explain "high pressure." "Low Pressure."

12—How is extra pressure for fighting fires secured?

13—What is the total capacity of the main pumping station?

c. Methods of Purification.

14—What impurities in drinking water are dangerous?

15—What are the chief sources of these impurities about Cleveland?

16—What methods of purification are used?

17—Describe (a) system one, (b) system two, as to method, size, capacity, efficiency, proportion of the city served.

18—Who is the judge of the quality of the water?

19—How often is the water tested by experts?

20—Are household filters commonly used? Are they safe?

21—Have there been any epidemics due to the local water supply?

d. Character of the Water.

22—Is the water clear and without sediment in the entire city?

23—Has the water any odor? Account for it.

24—How hard is the water of Lake Erie?

25—What substances are in solution?

26—Is the water supply ever affected by storms?

e. Consumption of Water.

27—What is the total cost of the water supply system?

28—What is the population of Cleveland?

29—What is the per capita cost of the system?

30—What is the water rate per 1000 cu. ft.?

31—What is the average daily consumption?

32—To what extent are meters used? Why?

33—Find the cost of water consumption in your home for one month.

34—State the program for future development of our water supply system.

f. Sewage System.
35—How is Cleveland's sewage disposed of?
36—Where are the exits of the trunk line sewers?
37—Does the sewage ever contaminate the water about the cribs?
38—What are our future plans for the disposal of sewage?
39—Has work been begun on the new projects?

g. Suggestions for a Report.
1—Make a map showing the location of intakes, pumping stations, reservoirs, filtration plants, with the distribution of raw, filtered, and mixed water.
2—Describe in detail the filtration process. Make a cross-section of a typical filter bed.

7. Some laboratory problems.
a. Is hard water satisfactory for domestic use?
b. Does all of the water receive the same treatment in the processes of purification?
c. Is there any relation between the number of cases of typhoid fever and the development of the water supply system?
d. Are all of the homes in Cleveland supplied with the same kind of water?
e. How does a rapid sand filter operate?
f. Where are the sewage disposal areas located? Why?
g. Are faucet filters desirable in the home?
h. A study of the Baldwin-Fairmount plant.

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Some Samples of Work Done by Ninth Grade Pupils in General Science

History of Cleveland's Water Supply System:

Wilbert ——————————. (*Ninth Grade*)

When Cleveland was discovered, people living along the shore of the Cuyahoga River could obtain pure and wholesome water from this stream. In the early days nearly every family had a well. Water for drinking purposes was obtained from springs and wells. There was a good spring on the square near the old courthouse, and also a spring of soft water on Superior Avenue near the entrance of the old Arcade. To supply water for washing purposes when rain water gave out, Benhu Johnson with his pony and cart, supplied water from the lake at 25 cents a load of two barrels. As Cleveland grew a waterworks system was needed which could supply Cleveland with pure and wholesome water.

The Cleveland waterworks were begun in August, 1854, the first water being used in September, 1856. The water was then obtained from a point in Lake Erie, three hundred feet from the shore and four hundred feet west of the western terminus of the old river bed. The intake was four feet below the surface and was connected with a fifty inch boiler plate pipe laid in twelve feet of water. The water was pumped to a standpipe and to a reservoir west of the Cuyahoga River. In February, 1866, it was found that owing to the formation of an ice bank along the water front, the flow of the Cuyahoga River had been diverted westward toward the intake, causing pollution. A strong odor of petroleum was noticed in the water also. In December a similar odor of petroleum was noticed, at times, in the water, due to a northeasterly gale and ice floes.

In 1867 and 1868 petroleum was noticed at times in the wa-

ter, and in 1869 the character of the water furnished was undesirable for domestic purposes, and work on a new intake was begun.

Work on the new waterworks tunnel was begun in 1869. The work was started by sinking a shaft on the shore, near the pumping station to the depth of 67 feet below the surface of the lake, and a tunnel 5 feet in diameter started at its bottom and extended outward. A crib (Fig. 4) 87 feet in diameter was towed out a distance of 6,600 feet from shore and sunk in 36 feet of water. It was then loaded down with thousands of tons of stone. A lake shaft was then sunk below the

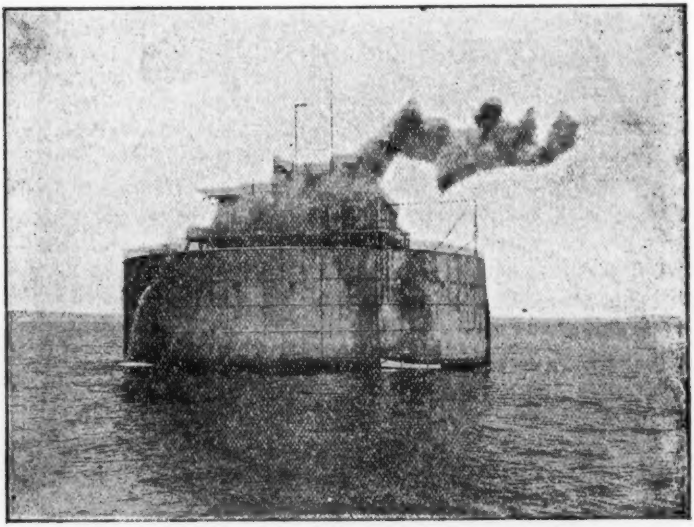

Fig. 4. One of the steel intake cribs of the water supply system of Cleveland. This crib supplies the Kirtland Pumping Station.

center of the crib, to a depth of 90 feet below the surface of the water and a tunnel started shoreward to meet the one coming from that direction.

Many difficulties in the way of quicksands were encountered while doing this work. On March 2, 1874, the work was finished and the water turned into it the next day. The total cost for building both crib and tunnel was $320,350. The crib was fitted up with a lighthouse and a house for the keeper. The quality of city water was greatly improved, but a rapid growth

of the city showed that something better and more efficient was needed. During the cold wave of the winter of 1875 the water had an insipid taste, due to the lack of oxygen resulting from thick ice. It is probable that contamination existed at this time. In 1877 the water of the new intake had a strong taste of petroleum and it was evident that the objectionable water from the river was reaching the crib. In March and December of 1881, the water of the new intake had a strong taste of petroleum. In 1882 a new and second tunnel was connected with the crib and it proved successful. The new additional tun-

Fig. 5. The Fairmount Low Service Reservoir, Cleveland, Ohio.

nel was 7 feet in diameter. A larger and more important step in the water supply was taken by building the Fairmount Distributing Low Service Reservoir. (Fig. 5)

The following year the "high service" pumping station was commenced. Work was begun on a new West Side Tunnel in 1888, and this addition was finished in 1891. The new East Side Tunnel was finally started in 1896. This was completed in 1904.

The water supply of Cleveland now comes from two pumping stations; the Division Avenue Station and the Kirtland Avenue Station (Fig. 6).

The West Side Tunnel has a capacity of 150 million gallons daily. The pumping equipment at the Division Avenue Station (Fig. 7) consists of three low-lift supply pumps which handle 150 million gallons daily. There are also two "high service" pumps which deliver 20 and 10 million gallons of filtered water a day. The present volume of water pumped into the mains by the Division Avenue plant is 120 million gallons daily. The Kirtland Avenue station consists of five low lift pumps which deliver 25 and 30 million gallons daily. The water distributed by this station is mostly chlorinated water. This station handled 42% of the city's supply in 1920. The Division Avenue station handled 58% of the city's supply. Besides the main pumping stations there are two secondary pumping stations, the Fairmount Station and the Warrensville Station, which repump water to reservoirs for first, second, and third "high service."

Fig. 6. One of the important pumping stations in Cleveland, The Kirtland Avenue Station.

The average volume of water pumped daily in 1857 was 348,-700 gallons, and in 1920, 140,337,000 gallons.

In 1920 the distribution system consisted of 1,452 miles of pipe and four reservoirs with a combined capacity of about 157 million gallons daily.

The total cost of the Cleveland system to date is estimated at $40,000,000. The water rate per 1000 cu. ft. is $.60 with a minimum rate of $6.00 per year. The future program provides

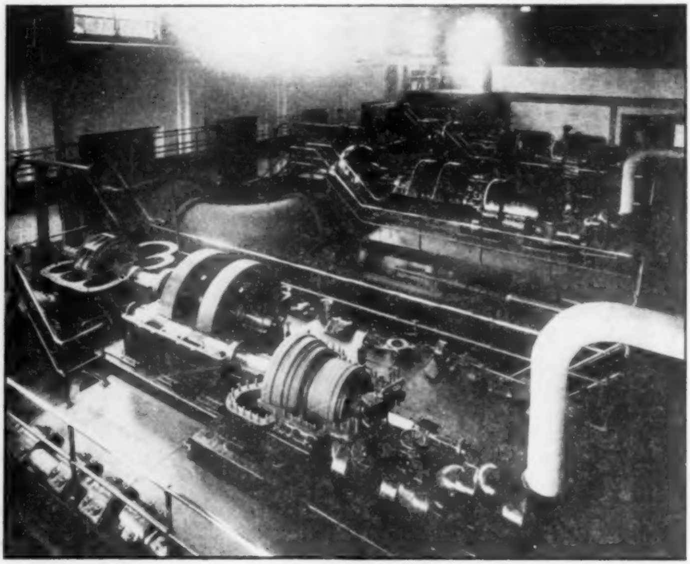

Fig. 7. Low lift pumps at the Division Avenue Pumping Station, Cleveland. These pumps furnish water to the filtration plant.

for two new tunnels and intake cribs, and increased pumping and reservoir capacity on both the East and West sides and an East Side filtration plant which is now being built.

The Process of Rapid Sand Filtration

Paul ——————————. (*Ninth Grade*)

The water is drawn from the tunnel through one-half inch screens. Centrifugal pumps force the water through a 72 in. steel pipe to the mixing chambers.

The chemicals that are needed are shipped by train to the chemical house. Here they are unloaded by scoop-shovels into

a chute which leads to a bucket elevator. This takes them to a worm conveyor which moves the chemicals to bins. The chemicals are taken to scales through large chutes. There are four (Richardson) automatic scales set for seventy pounds of lime per dump, and other scales set to weigh 30 pounds of iron sulphate at each dump. Lime to the extent of .6 of a grain is used for every gallon of water. Eight-tenths of a grain of iron sulphate is used for every gallon of water.

After these chemicals have been put into the water in solu- lime per dump, and other scales set to weigh 30 pounds of iron bers where, for about three quarters of an hour, it is forced back and forth through narrow channels. This mixes the chemicals thoroughly.

The water is then led into the coagulation basins. In these basins the chemicals attract the dirt and fall to the bottom. This process continues for about four hours. About seventy-five percent of the dirt is taken out of the water in this process. There are six of the settling basins each holding three and one-half million gallons. Each is independent of the others, and can be cleaned at will. This is usually done once in six months. From here the water flows into the filters (Fig. 8) through 48 inch pipes.

In the filters the water flows through sand and gravel which take out practically all the suspended matter that escaped the first process. In each filter there are 27 inches of quartz sand and 22 inches of gravel. There are thirty-six of these filters, each having a capacity of about four million gallons per twenty-four hours. The filtered water flows into the clear water reservoir where one pound of liquid chlorine (Fig. 9) is applied per million gallons. From this point the water is pumped to reservoirs and the city mains. The filters are washed every ten to twenty hours according to the condition of the water. This is done by reversing the flow of the water through the filter. About 75,000 gallons of water are necessary to wash each filter.

In the laboratory samples are taken every eight hours of raw, settled, filtered, and chlorinated water. Tests show that there are some bacteria in the raw water, less in the settled, very few in the filtered, and practically none in the chlorinated water.

Fig. 8. The operating gallery of the Division Avenue Filters.

(AN OUTLINE TO BE PLACED IN THE HANDS OF PUPILS)

Problem E: The Rapid Sand Filter.

PROBLEM:

How does a rapid sand filter operate?

WHAT TO USE:

1. Sample of raw water from the shore of Lake Erie.
2. Water from the unfiltered district.
3. Water from the mixed district.
4. Water from the filtered area.

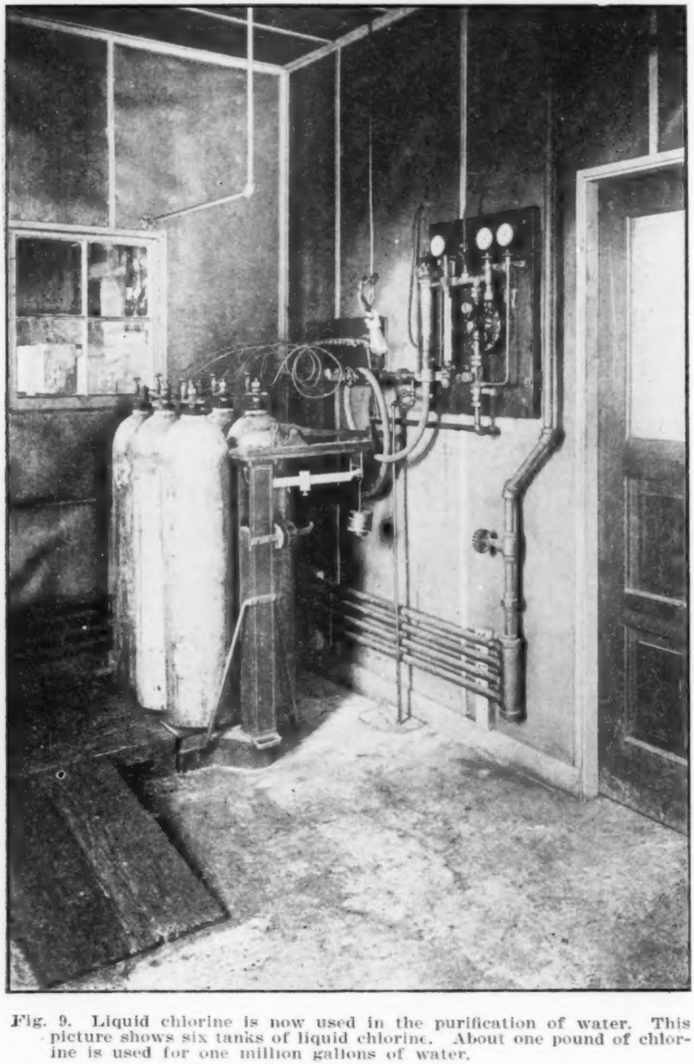

Fig. 9. Liquid chlorine is now used in the purification of water. This picture shows six tanks of liquid chlorine. About one pound of chlorine is used for one million gallons of water.

5. A minature filter made of glass tubing forty inches long and two inches in diameter.

WHAT TO DO:

1. Examine each sample in regard to color, sediment, organic matter.
2. Test each sample for organic matter using sulphuric acid and potassium permanganate.
3. Put the raw water through the filter and observe the results.
4. Test the filtered water again for oganic matter.

QUESTIONS:

1. Does Cleveland have the same kind of water in all parts of the city?
2. State the different kinds used in the different areas?
3. What is meant by the term "mixed water"?
4. Why is chlorine used?
5. Does filtered water contain any sediment?
6. In what sense is filtered water better than chlorinated water?
7. Which samples contained organic matter?
8. Why is organic matter dangerous?
9. State what effect storms have on the condition of our water supply.
10. What effect did filtration have on the raw water?
11. Why has chlorinated water less sediment and of a finer nature than shore water?
12. What proportion of the city has filtered water? Raw? Mixed?

REPORT:

State your results in tabular form. Draw the apparatus according to the scale of one inch to ten inches.

Report on Problem E: The Rapid Sand Filter.

Arthur ————————. (*Ninth Grade*)

PROBLEM:

How does a rapid sand filter operate?

QUESTIONS:

1. Cleveland does not get the same kind of water throughout the city.
2. The city is divided into three different water districts. The west side gets filtered water. A strip extending from E. 55th Street to E. 133rd Street, from the Lake to Kinsman Avenue, gets raw water, or chlorinated water. All the rest, get mixed water.
3. The meaning of the term mixed water, is that the district gets sometimes raw water, and another time gets filtered water, and sometimes a mixture of the two.
4. Filtered water does not contain any sediment.
5. Chlorine is used in the water to kill the germs.
6. Filtered water is better than chlorinated water because it is purer, and does not contain any sediment, while chlorinated water does.

Kind of Water	Color	Sediment	Organic Matter
Raw water Lake Erie Shore	Very turbid	Very Much	Visible and test for it
Chlorinated or raw water	Somewhat turbid	Some	A slight test
Mixed water	Almost clear	Very little	None
Filtered water	Clear	None	None

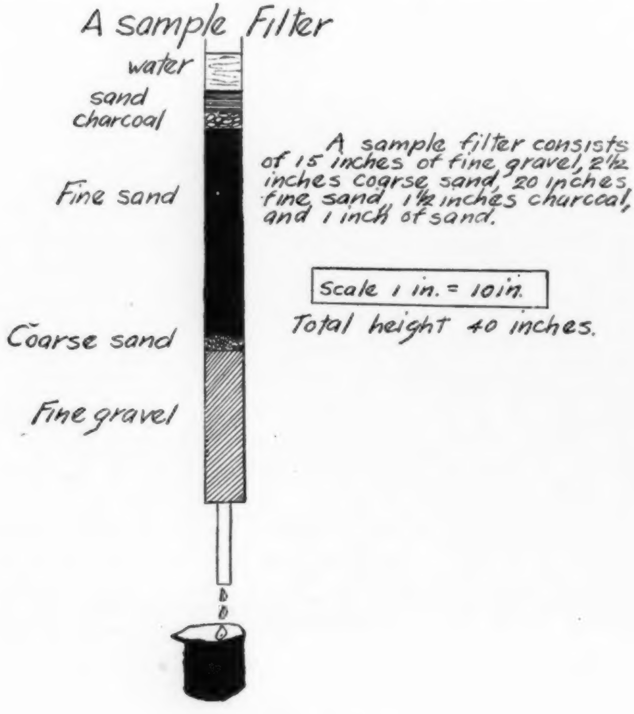

Fig. 10. The rapid sand filter.

7. The waters that contain organic matter are, raw water from the lake shore, and chlorinated water.
8. Organic matter is dangerous, for it may contain bacteria.
9. When there is a storm, the rain washes down soil, and other substances, and these flow into rivers and canals, and then finally into the lake. Strong off-shore winds drift these impurities, and sediment, out near the cribs thus making the water at such times more turbid, more dangerous, and harder to filter.
10. When you filter raw lake shore water, it will be clear when coming out of the filter.
11. Chlorinated water has less sediment, because the water is taken 4½ miles out in the lake, where it is purer, and cleaner, than from the shore.
12. About 58% of the city of Cleveland gets filtered water, and about 10% get raw water, and about 32% gets mixed water.

The results on the experimental work will be found in figure 10.

SAMPLES OF EXHIBITS PREPARED BY GENERAL SCIENCE PUPILS (NINTH GRADE)

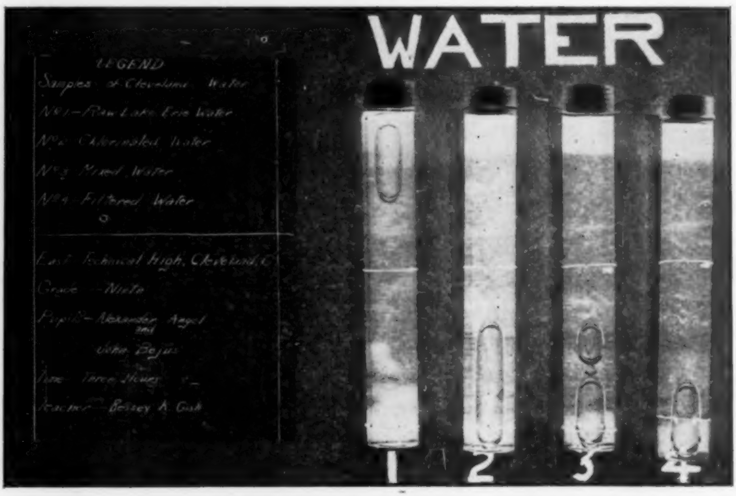

Fig. 11. Samples of water taken in different parts of Cleveland.

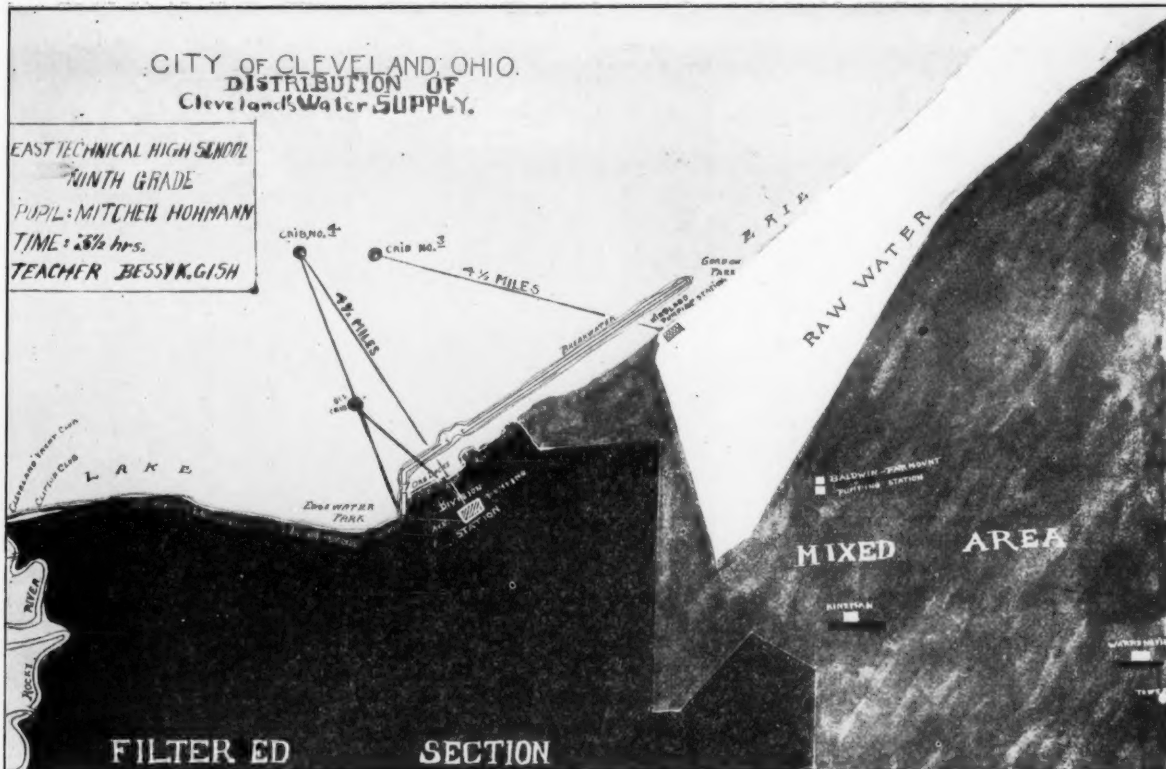

Fig. 12. The sections of Cleveland that use filtered water, raw water (from Lake Erie), and mixed water.

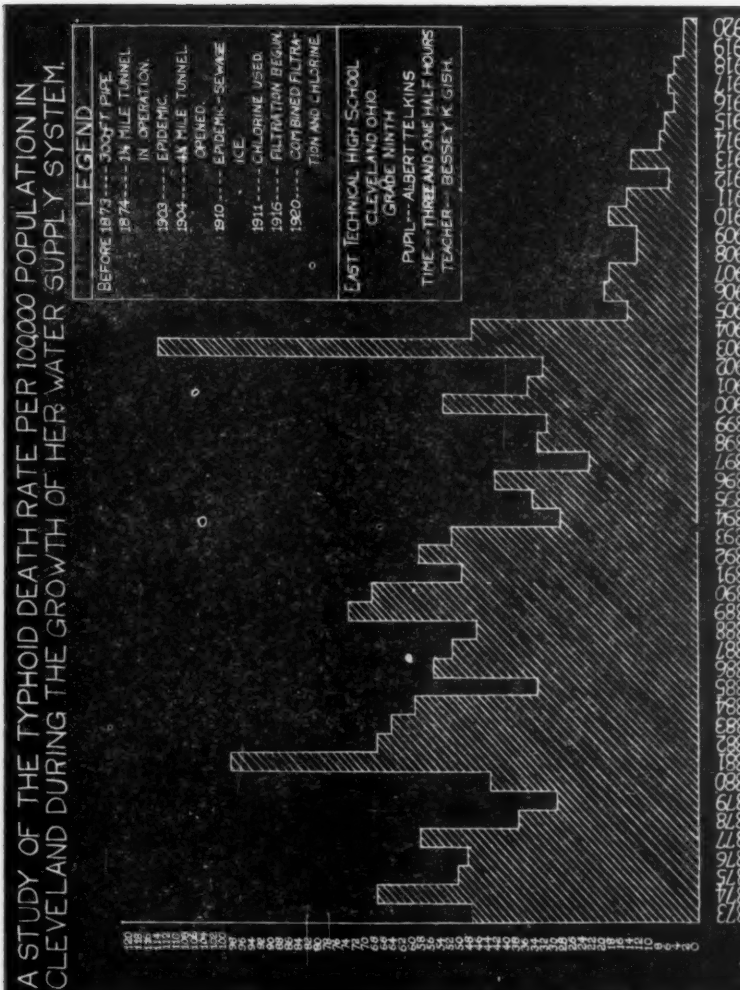

Fig. 13. The decrease in the typhoid fever death rate resulting from the application of scientific methods in the control and distribution of the city water supply.

Book Reviews

The Teaching of General Science—W. L. Eikenberry—169 pages—$2.10 jostpaid—University of Chicago Press.

The training of general science teachers is assuming more and more importance every year. Large cities are now offering examinations for teachers in general science and the day is passing when any teacher, regardless of preparation, can be assigned to teach the general science. This excellent little volume will do much to give those who choose to teach general science in elementary schools or high schools a point of view from which to work out their own class problems. It gives the education student the present status of general science and for his investigation it offers a good list of sources of material on general science work already done. It covers the following subject matter: Some Historical Considerations; Criticism of Science Teaching; Roads toward Reform; Objectives in General Science; General Science and Method; The Subject Matter of the General Science Course; Principles of Organization; Examples of Organization; The General Science Teacher; Bibliography of General Science. It is a book that every general science teacher should own and which should find a place in normal schools, summer schools, and schools of education.

Gardening—A. B. Stout, New York Botanical Garden—354 pages—Illustrated with drawings and photographs—Price $1.60—World Book Company.

This elementary school text treating of the science and art of vegetable growing presents theory and practice together. It is as nearly complete as any one book on gardening could be; it is scientifically accurate, and the contents have been made applicable to all sections of the country.

The first chapters deal with the fundamental relations between plants and their environment. Principles of growth and reproduction are explained so that the needs of garden plants can be understood.

Dr. Stout deals with one subject little known to the average gardener—seed-growing and plant-breeding. A knowledge of this subject is of great value in work with plants, and in this book is a very complete and authoritative treatment.

The book is designed especially for junior high school grades. The subject is developed through a combination of home and school activities and is correlated with other school subjects. Each chapter is followed by exercises that train the student to work out his own problems.

Vegetable Growing Projects—Ralph L. Watts—Illustrated—318 pages—The Macmillan Company.

The twenty-one vegetable growing projects in this book are practical helps to the home gardener as well as to the market gardener. Chapter I gives a valuable seasonal program and the projects follow. Each project has a brief introduction, pertinent questions and the project outline; then follows the text with numerous questions, many of which are to be answered by reference to other books which are named. The starting, growing and marketing of crops are all treated. Particularly good are the suggestions for combating insects and diseases. The final chapter on the home garden is suggestive and helpful to all those who have a little ground which may be used for the garden plot.

Standardized Science Tests—General Science—A. Bromley Barber, Clayton, New Mexico.

Four tests are given on a four page sheet. There are 25 questions in each test. The types of tests are illustrated by the following samples:

1. The propeller is a part of a (machine gun, air-plane, gas engine)
2. The following foods rank in this order, according to the fat they contain: sugar (......); butter (......); milk (......).
3. Malaria is spread by (............).
4. Clara wishes to cook an egg for her sick mother. Should she fry, poach, or boil it?

Vocational Guidance—L. L. Thurston—The World Book Company.

This series of prognostic tests includes: Technical Information test, Physics Test, Arithmetic Test, Algebra Test, Geometry Test.

The tests are designed to test the machinery and engineering aptitude of high school and college students and to foretell with some certainty their probable success in pursuing engineering careers.

The Earth and It's Life—A. Waddingham Seers—208 pages—Illustrated—$1.20—World Book Company.

This book contains a clear account of the origin of our planet in the light of modern science. It recounts the story of evolution, culminating in the origin of man, and relates man's struggles against the animal world with his eventual triumph, and his conquest of the earth through the discovery of the means of locomotion.

Anyone above twelve years of age will be fascinated by this story of the earth's history. It has both cultural and scientific value and will particularly appeal to those science teachers who are interesting their pupils to work out projects upon which they may report to the class.

Elementary Industrial Arts—L. L. Winslow—335 pages—Illustrated—Macmillan Company.

This book emphasizes the fact that there is a social and cultural value derived from the study of industry in addition to the material side. Real projects are offered in the suggestion that pupils carry out some of the various industrial activities. Many of the industries covered involve science and will be found of value as supplementary reading material for general science, as well as for arts and manual training pupils. Some of the chapter titles are: Paper Making; Brick and Tile; Pottery Industry; Cement and Concrete; Textiles; Copper; Iron and Steel; Soap; Glass. The text is appropriate in style and language to boys and girls of the upper elementary grades. Each chapter closes with a appropriate poem, exercises for study and review, and a list of books for supplementary reading.

An Elementary Manual of Physiology—Russell Burton-Opitz M. D. —411 pages—147 illustrations—cloth $2.50—W. B. Saunders Company.

This text presents the subject-matter of physiology in a simple and logical manner. It contains the essential facts about the human body which ought to be understood more generally. The book is adapted to the use of students in colleges, normal schools, schools of physical education, and schools of nursing. The book is divided into six parts, as follows: Physiology of Muscle and Nerve; Circulation of the Blood and Lymph; Respiration; Nutrition; Nervous System; Sense Organs. The book will also be found a valuable reference for high schools.

Vitamin Charts:

Two valuable charts on vitamins have been printed by the American Medical Association of Chicago. The price is 40 cents each. The first chart contains the following facts.

Vitamins are constituents of our food that are essential to health.
Three vitamins are known at present: "A," "B" and "C".
A deficiency of "A" in the diet may result in symptoms of rickets and an eye disease (Xerophthalmia).
A deficiency of "B" in the diet may result in loss of appetite and symptoms of the disease Beriberi.
A deficiency of "C" in the diet may result in symptoms of scurvy.
A deficiency of any of the vitamins in the diet of children will result in stunted or impaired growth.
It is not necessary to buy "patent medicine" vitamins in tablet form.
A diet containing all the vitamins necessary can easily be selected from our every day foods!

The second chart is represented in miniature below.

VITAMINS IN FOODS

	"A"	"B"	"C"		"A"	"B"	"C"
BREAD, WHITE (WATER)	?	+	—	TOMATOES (RAW OR CANNED)	++	+++	+++
" , " (MILK)	+	+	?	BEANS, KIDNEY	*	+++	*
" WHOLE WHEAT (WATER)	+	++	?	" , NAVY	*	+++	—
" , " " (MILK)	++	++	?	" , STRING (FRESH)	++	++	++
BARLEY (WHOLE)	+	++	—	CABBAGE, FRESH, RAW	+	+++	+?
CORN, YELLOW	+	++	—	" , COOKED	+	++	+?
OATS	+	++	—	CARROTS, FRESH, RAW	++	++	++
MEAT, LEAN	— to +	+?	+?	" COOKED	++	+	+
BEEF FAT	+	—	—	CAULIFLOWER	+	++	+
MUTTON FAT	+	—	—	CELERY	*	+	*
PIG KIDNEY FAT	++	—	—	CUCUMBER	*	+	*
OLEOMARGARINE	+	—	—	DANDELION GREENS	++	++	+
LIVER	++	++	+	EGGPLANT, DRIED	*	++	*
KIDNEY	++	++	+?	LETTUCE	++	++	+++
BRAINS	+	++	+?	ONIONS	*	++	++
SWEETBREADS	+	+	*	PARSNIP	—?	++	*
FISH, LEAN	—	+	*	PEAS	++	++	+?
" , FAT	+	+	*	POTATOES (BOILED 15 MIN.)	*	++	+?
" , ROE	+	++	+?	" (" 1 HOUR)	*	++	+?
MILK, FRESH	+++	++	+V	" (BAKED)	*	++	+
" , CONDENSED	+++	++	+V	SWEET POTATOES	++	+	*
" , DRIED, (WHOLE)	+++	++	+V	RADISH	*	+	*
" , SKIMMED	+	++	+V	RUTABAGA	—?	++	+++?
BUTTERMILK	+	++	+V	SPINACH, FRESH	+++	+++	*
CREAM	+++	++	+V	" , DRIED	+++	++	*
BUTTER	+++	—	—	SQUASH, HUBBARD	++	*	*
CHEESE	++	*	*	TURNIPS	—?	++	*
COTTAGE CHEESE	+	*	*	APPLES	+	+	+
EGGS	++	+	+?	BANANAS	+?	+?	+
ALMONDS	+	+	*	GRAPE JUICE	*	+	+
COCONUT	+	++	*	GRAPEFRUIT	*	++	++
HICKORY NUTS	*	++	*	LEMON JUICE	*	++	+++
PEANUTS	+	++	*	ORANGE JUICE	+	++	+++
PECANS	*	+	*	PRUNES	*	+	—
WALNUTS	*	++	*	RASPBERRIES (FRESH OR CANNED)	*	*	+++

+ contains the Vitamin
++ good source of the Vitamin
+++ excellent source of the Vitamin
— no appreciable amount of the Vitamin
? doubt as to presence or relative amount
* evidence lacking or insufficient
V variable

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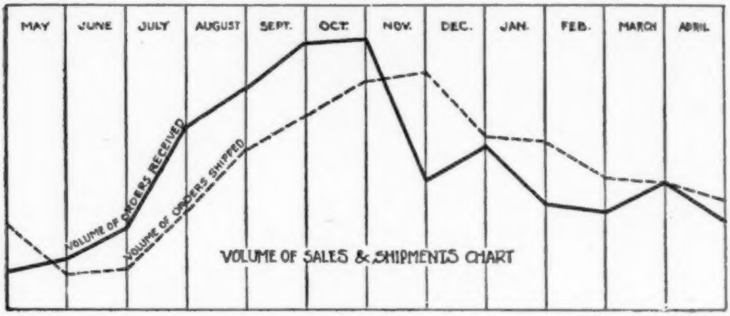

It is the usual practice of High Schools to purchase their laboratory supplies in August or September for immediate use. The sales chart shown above was made from the actual figures of a year's business. It shows that 63 per cent. of our school business is received during the August to October period, while only 15 per cent. is received in the April to June period. This means that our organization must handle four times the number of orders in the busy season that they handle in the dull season. We must employ and retain throughout the year a staff of experts for administration and supervision sufficiently large to handle the rush business of the August to October period. This adds to the cost of your equipment.

If you will endeavor to purchase a part of the supplies you will require for next school year this spring, you will help to eliminate the expensive rush season.

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General Science in the Summer Schools

BATES COLLEGE, Lewiston, Maine.

Subject-matter in General Science: Lectures, lantern slide talks, laboratory work and discussions. Aims to bring to the general science teaches a broad fund of usable information. *Howard C. Kelly* and *Donald B. Stevens*, High School of Commerce, Springfield, Mass.

CLEVELAND SCHOOL OF EDUCATION, Cleveland, Ohio.

The Teaching of General Science in the Junior High School. Deals with content and methods in the field of General Science. Detailed lesson outlines will be presented and general problems of science teaching. Field lessons will be given and afternoon trips. *Chester A. Mathewson*, Cleveland School of Education. In connection with this course a demonstration class will be conducted daily by Mr. Mr. Henry P. Harley, in the Fairmount Junior High Demonstration School.

COLUMBIA UNIVERSITY, TEACHERS COLLEGE, New York City.

The Teaching of General Science in Secondary Schools... Deals with content, methods, field work, text books, library work, equipment and reference readings. A ninth grade class in the demonstration school will be in session. *Earl R. Glenn*, Lincoln School of Teachers College.

CORNELL UNIVERSITY, Ithaca, New York.

Teachers Course in General Science. A description of purpose, scope and administration of a course in General Science in secondary schools. *Clarence F. Hale*, Professor of Physics, New York State College for Teachers, Albany, New York.

UNIVERSITY OF CALIFORNIA, Los Angeles.

Nature Study, Elementary Agriculture and General Science. General construction of principal subject matter and methods of supervisors and normal and teachers college instructors. *Clayton F. Palmer.* Supervisor of Agriculture, Los Angeles, California.

CHICAGO NORMAL COLLEGE, Chicago, Ill.

Elementary Science: This will be a laboratory course in general science for the elementary schools. Twenty-five exercises should be worked out during the course. *Mr. Whitten.*

UNIVERSITY OF CHICAGO, Chicago, Ill.

The Teaching of General Science: Reasons for and causes leading to the teaching of general science; selection and organization of course in Junior High School; type courses, equipment; correlation; tests. *Charles J. Pieper*, University High School.

NEW YORK UNIVERSITY, New York, N. Y.

Teaching of General Science: The aims and values of elementary science, the sources and selection of material, and the principles of organization with reference to the project method will constitute the matter of his course. *Edgar A. Bedford,* DeWitt Clinton High School, N. Y. C.

STATE NORMAL UNIVERSITY, Normal, Ill.

General Science: The course will cover the purpose, the place, and the content of a course in general science in the high school. Recent literature such as texts and outlines will be studied. *Fred D. Barber*, State Normal University.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.

Content Course in General Science: For those preparing to teach general science. Laboratory work is given in connection with this course. In connection with this work a class in general science, in the Demonstration High School, will be organized from the standpoint of the Junior High School. *Edward E. Wildman*, West Philadelphia High School for Girls.

UNIVERSITY OF PITTSBURGH, Pittsburgh, Pa.

The Teaching of Science in Secondary Schools: This course covers the basic pedagogy of all secondary school science subjects. Students will work intensively in their special fields. Observation of the teaching of general science in the Demonstration School. *W. W. D. Sones*, Schenley High School, Pittsburgh.

UNIVERSITY OF WISCONSIN, Madison, Wisconsin.

Teaching of General Science: The aims, development and organization of general science to the other courses in science; the specific problems of general science in the Junior High School. Possibilities of the project method. *Ira C. Davis*, University High School.

STATE NORMAL SCHOOL, Emporia, Kansas.

General Science. A course for teachers. Emphasis will be placed on the project method of teaching general science. *Lyman C. Wooster*, Kansas State Normal School.

UNIVERSITY OF NEBRASKA, Lincoln, Nebraska.

Sciences of the Junior High School. Selection and organization of the subject matter of general science. *B. Clifford Hendricks*, University of Nebraska.

RELATED SCIENCE METHODS

Special methods in presenting elementary science in its relation to homemaking problems, giving emphasis to the selection and presentation of subject-matter. Asst. State Supervisor of H. Econ. Educ.

Science Articles in Current Periodicals

AERONAUTICS

Winged surveyors. Ill. S. H. Fairchild. Sci. Am. 126: 157. Mar. 1922.

Surveying from the air. Ill. Col. E. Lester Jones. Jo. Fr. Inst. 193:461-490. Apr. 1922.

Soaring birdmen. Ill. L. d'Orcy. Sc. Am. 126:235-7. Apr. 19, 1922.

Why the mail plane? Ill. C. H. Claudy. Sc. Am. 126:250-1. Apr. 1922.

U. S. S. "Wright": Our first balloon and airship carrier. Ill. Sc. Am. 126:267. Apr. 1922.

Flying in America. Ill. Wm. Mitchell. Pop. Sc. Mo. 100:4: 24-6. Apr. 1922.

Travelling by air in England. Lit. Dig. 73:4:22. Apr. 22, 1922.
First Alaskan air expedition. Ill. St. Clair Streett. Nat. Geog. Mag. 61:499-552. May 1920.

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Is the Corn belt drying up? Lit. Dig. 73:3:24. Apr. 15, 1922.
Heating orchards with stoves. Lit. Dig. 73:3:25. Apr. 15, 1922.
Cuban agriculture. Ill. R. H. Whitbeck. Geog. Rev. 12:223-240. Apr. 1922.
How acid is an acid soil? E. T. Wherry. Gar. Mag. 35:184. May 1922.

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Behind the menagerie guard ropes. Pop. Mech. 37:705-710. Apr. 1922.

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So. Georgia—an outpost of the Antarctic. Ill. R. B. Murphy. Nat. Geog. Mag. 61:409-444. Apr. 1922.

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Some erroneous ideas of Arctic geography. V. Stefanson. Geog. Rev. 12:264-277. Apr. 1922.

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To the center of the universe. Isabel M. Lewis. Sc. and Inv. 9:1010. March 1922.
Dark markings in the sky. Ill. Isabel M. Lewis. Sc. and Inv. 9:1126. Apr. 1922.
Oxygen and water vapor absent from atmosphere of Venus. I. M. Lewis. Sci. and In. 10:28. May 1922.

AURA

The human atmosphere. A. A. Hopkins. Sci. Am. 126:200. Mar. 1922.

AUTOMOBILES

A steam car that is different Ill. Sc. Am. 126:262. Apr. 1922.
Rules governing approval of headlight devices. Tr. Ill. Eng. Soc. 17:105-112. Feb. 1922.
Gearless friction drive car. Sci. and Inv. 10:27. May 1922.

CARBON MONOXIDE

Physiological effects of exposure to low concentrations of carbon monoxide. Sayer, Meriwether and Yant. Jo. Fr. Inst. 193:704-5. May 1922.

CALENDAR

The 200-year calendar. Sc. and Inv. 9:1137. Apr. 1922.

CANNING

Packing perishable foods in inert gas. Sc. Am. 126:255. Apr. 1922.
Some research problems of the canning industry. W. D. Bigelow. Jo. Ind. & Eng. Chem. 14:375-9. May 1922.

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Portland Cement. P. H. Bates. Jo. Fr. Inst. 193-283-309. Mar. 1922.

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A new aid in street planning; aerial photography. N. P. Lewis. Am. City. 24:209. Mar. 1922.

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Fogs and clouds. Ill. W. J. Humphreys. Jo. Fr. Inst. 193:_ 7-230. Feb. 1922 and 193:327-384 Mar. 1922.

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Control of corrosion by deactivation of water. Ill. Frank N. Speller. Jo. Fr. Inst. 193:515-542. Apr. 1922.

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The winning fight against mental disease. Ill. B. G. Lewis. Rev. of Rev. 65:411. Apr. 1922.

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Can we still believe in evolution? Cur. Opin. 72:644. May 1922.

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Flashlights and flashlight batteries. Eugene A. Mathews Trans. Ill. Eng. Soc. 17:135-146. Mar. 1922.

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Roses. Gar. Mag. 35:1:18-23. Mar. 1922.
Telling the time in flowers. Jane L. Kift. Gar. Mag. 35:1:26. Mar. 1922.
Cut flowers for every day. Carl Stanton. Gar. Mag. 35:1:34. Mar. 1922.
Gardening with wild flowers. Ill. A. Z. Hill. Gar. Mag. 35:191. May 1922.

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Heating orchards with stoves. Lit. Dig. 73:3:25. Apr. 1922.

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Grafting. E. L. D. Seymour. Gar. Mag. 35:124-6. Apr. 1922.
Bramble fruits for the home garden. J. L. Doan. Gar. Mag. 35:105. Apr. 1922.
Tying the house to the garden. Ill. E. C. Stiles. Gar. Mag. 35:99-103. Apr. 1922.
Strawberries. J. L. Doan. Gar. Mag. 35:1:27. Mar. 1922.

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Gasoline from oil shale. Ill. Ralph H. McKee. Jo. Fr. Inst. 193:311-326. Mar. 1922.

HELIUM

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Where justice hangs by a hair. Ill. J. A. Ford. Pop. Mech. 37:571-573. Apr. 1922.

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The physical basis of heredity. James B. Kelly. Sci. Am. 126: 177. Mar. 1922.

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Fighting insects with airplanes. Ill. Neillie and Houser. Na. Geog. Mag. 61:333-338. Mar. 1922.
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Darts of light. C. E. K. Mees. Sci. Am. 126:336. May 1922.
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MARKETING

A course in marketing. N. B. Bailey. Jo. Home Econ. 14:220-2. May 1922.

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The scenery of North America. Ill. James Bryce. Nat. Geog. Mag. 61:339-389. Apr. 1922.

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How a piano is made. Ill. W. J. Byrnes. Com'l Amer. 18:11: 35. May 1922.

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Peeping through the curtains of the ages: Aztec Ruins. Ill. R. P. Crawford. Pop. Mech. 37:537-543. Apr. 1922.

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Photography of bullets in flight. Ill. Philip P. Quayle. Jo. Fr. Inst. 193:627-640. May 1922.

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Radio loud-talkers. Henry Townsend, Jr. Sc. and Inv. 9:1146. Apr. 1922.
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The A B C's of radio. Armstrong Perry. Pop. Sc. Mo. 100:5: 30. May 1922.
The boy who gave us wireless: Marconi. Pop. Sc. Mo. 100:5: 65. May 1922.
Combining radio and wire telephony. Lit. Dig. 73:3:29. Apr. 15, 1922.
Radio for everybody. A. C. Lescarboura. Sci. Am. 126:166. Mar. 1922.
Radio Department. Lit. Dig. 73:4:26-29. Apr. 22, 1922.
Long distance radio communication. Ill. L. W. Austin. Jo. Fr. Inst. 193:437-459. Apr. 1922.
Radio for a beginner. Ill. A. Perry. Sc. and Inv. 9:1044. Mar. 1922.
The long arm of radio is reaching everywhere. Cur. Opin. 72: 684-687. May 1922.
The man who made broad casting possible. Lit. Dig. 73:5:23. Apr. 29, 1922.
Radio construction hints. H. W. Secor. Sci. and Inv. 10:53. May 1922.
Taking the riddles out of radio. Geo. H. Dacy. Sci. Am. 126: 298. May 1922.
The Jinn in the radio bottle. Lit. Dig. 73:7:27. May 13, 1922.
A short-wave radio-telephone receiver. F. L. Brittin, Pop. Mech. 37:963-8. June 1922.

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Scientific road legislation. C. H. Claudy. Sci. Am. 126:264. Apr. 1922.

SHACKLETON

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Prehistoric telephone days. Ill. Alexander Graham Bell. Nat. Geog. Mag. 61:223-241. Mar. 1922.

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Tides in the Bay of Fundy. Ill. H. A. Marmer. Geog. Rev. 12:195-205. Apr. 1922.

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American City. The Tribune Building, N. Y. C. Monthly. $4.00 a year, 50c a copy. The science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher reference.

American Forestry. Washington, D. C. Monthly. 40c a copy, $4.00 a year. Splendid pictures for plant and tree study.

Commercial America. Phila. Com'l Museum, Phila., Pa., $2.00 a year. Ill. Commercial production. New Inventions. Will interest Commercial geography and science teachers.

Current Opinion. 65 W. 36 St., N. Y. Monthly. 35c a copy, $4.00 a year. Has a regular department "Science and Discovery" containing articles of popular interest, adapted to pupil or teachers.

The Educational Screen—5200 Harper Avenue, Chicago. Monthly 15c copy, $1.00 a year. Discusses the use of movies in our schools; gives brief descriptions of educational films and lists theatrical films which are suitable for children. The journal is entirely educational having no commercial affiliations.

Experimental Science. 1311 G St. Washington, D. C. Monthly. 15c a copy, $1.50 a year. An interesting boys' magazine. Strong on wireless.

Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $3.00 a year. Ill. Helpful to amateur gardeners, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 40c a copy, $1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable articles in current periodicals.

The Geographical Review. Broadway at 156th St., N. Y. $1.25 a copy $5.00 a year. Devoted to scientific geography. Original maps and pictures. One department contains condensed items of topics of current interest.

The Guide to Nature. Sound Beach, Conn. Monthly. 15c a copy, $1.50 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Illustrated World. Drexel Ave. and 58th St., Chicago. Monthly. 25c a copy, $3.00 a year. Many short articles on applications of science and mechanics. Popular in style and attractive to elementary and high school pupils.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $6.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 1121 Cathedral St., Baltimore. Monthly. 25c a copy, $2.50 a year. For teachers.

The Literary Digest. 354 Fourth Ave., N. Y. Weekly. 10c a copy, $4.00 a year. Has a department "Science and Invention." Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

Journal of Industrial and Engineering Chemistry. Box 505, Washington, D. C. Monthly. 75c a copy, $7.50 a year. A technical journal which contains much material which teachers can use.

National Geographic Magazine. Washington, D. C. Monthly. 50c a copy, $3.50 a year. Best monthly journal for high grade pictures. Articles are of interest to general reader, pupils and teachers, as well as to geographers.

TRANSPORTATION

Automatic train control made obligatory. C. H. Claudy. Sci. Am. 126:314. May 1922.

VIVISECTION

An American Cardinal on vivisection. Cur. Opin. 72:663. May 1922.

WATER POWER

Curbing the Colorado. Ill. R. G. Skerrett. Sc. Am. 126:246. Apr. 1922.

Super-dam will harness the mighty Colorado. J. A. Ford. Pop. Cc. Mo. 100:5:55. May 1922.

Moving Niagara into Canada. Ill. T. F. Springer. Sci. Am. 126:162. Mar. 1922.

WEATHER

The case against "Rain-making." Rev. of Rev. 65:104. Jan. 1922.

Weather Control. D. W. Herring. Sci. Mo. 14:178. Feb. 1922.

Composite temperature types of the United States. Robert De. C. Ward. Geog. Rev. 12:116. Jan. 1922.

Can We Make Rain. Ill. T. O. Sloane. Sci. and Inv. 9:500. Oct. 1921.

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Wide spread use of radio telephone. Rev. of Rev. 65:102. Jan. 1922.

The radio central. A. C. Lescarboura. Sci. Am. 126:8. Jan. 1922.

WOOD

Figure in wood. Ill. S. J. Record. Am. For. 27:611. Oct. 1921.

X-RAYS

Roentgen-ray photography. P. J. Risdon. Sci. Am. 126:182. Mar. 1922.

Nature Study Review. Ithaca, N. Y. Monthly. 20c a copy, $1.50 a year. An illustrated journal for teachers of nature study.

Popular Mechanics Magazine. Chicago. Monthly. 25c a copy, $3.00 a year. Short science items and articles well illustrated. Appeals strongly to elementary pupils. Suggest many construction projects.

Popular Science Monthly. 255 West 39th St. N. Y. C. Monthly. $3.00 a year, 25c a copy. A Review in text and pictures of the news of science and invention presented in a humanistic and inspirational way. Used as a supplement to text-books in many high schools. Valuable to science pupils and teachers.

Review of Reviews. 30 Irving Place, N. Y., N. Y. Monthly. 35c a copy, $4.00 a year. An illustrated monthly covering world affairs. Contains many good articles bearing on science, suitable for class reports.

Safety Engineering. 80 Maiden Lane, New York. Monthly. $3.00 a year. 25c a copy. A journal devoted to conservation of life and property and contains much material helpful in science classes.

School Science and Mathematics. Chicago. Monthly. $2.50 a year. A teacher's journal. Includes many helpful suggestions.

Scientific American. Woolworth Building, N. Y. Monthly. 35c a copy, $4.00 a year. Has longer articles than the other popular science journals. Illustrated and is particularly valuable to high school science pupils and teachers.

Science and Invention. 233 Fulton Street, N. Y. Monthly. 25c per copy, $2.50 a year. Ill. Popular articles on astronomy, physics, photography, radio-activity, medicine, and in fact, science in general.

Scientific Monthly. Garrison, N. Y. 50c a copy, $5.00 a year. Articles as a rule are more along lines of pure science. Much of value to teachers. Articles can be read to advantage by many pupils.

The Screen. 114 West 44th St., N. Y. Monthly. 10c a copy. $1.00 a year. Articles on use of motion pictures and descriptions of films.

Transactions of the Illuminating Engineering Society. 29 W. 39th St., N. Y. Monthly. $1.00 a copy, $7.50 a year. Technical. Many articles contain material which can be used in high school classes.

Visual Education. 806 W. Wash. Blvd., Chicago. Monthly. 15c a copy. $1.00 a year. Discusses films, film making and the various visual aids for school use.

Indexes to Volumes V and VI